MECHANICAL ENGINEERING

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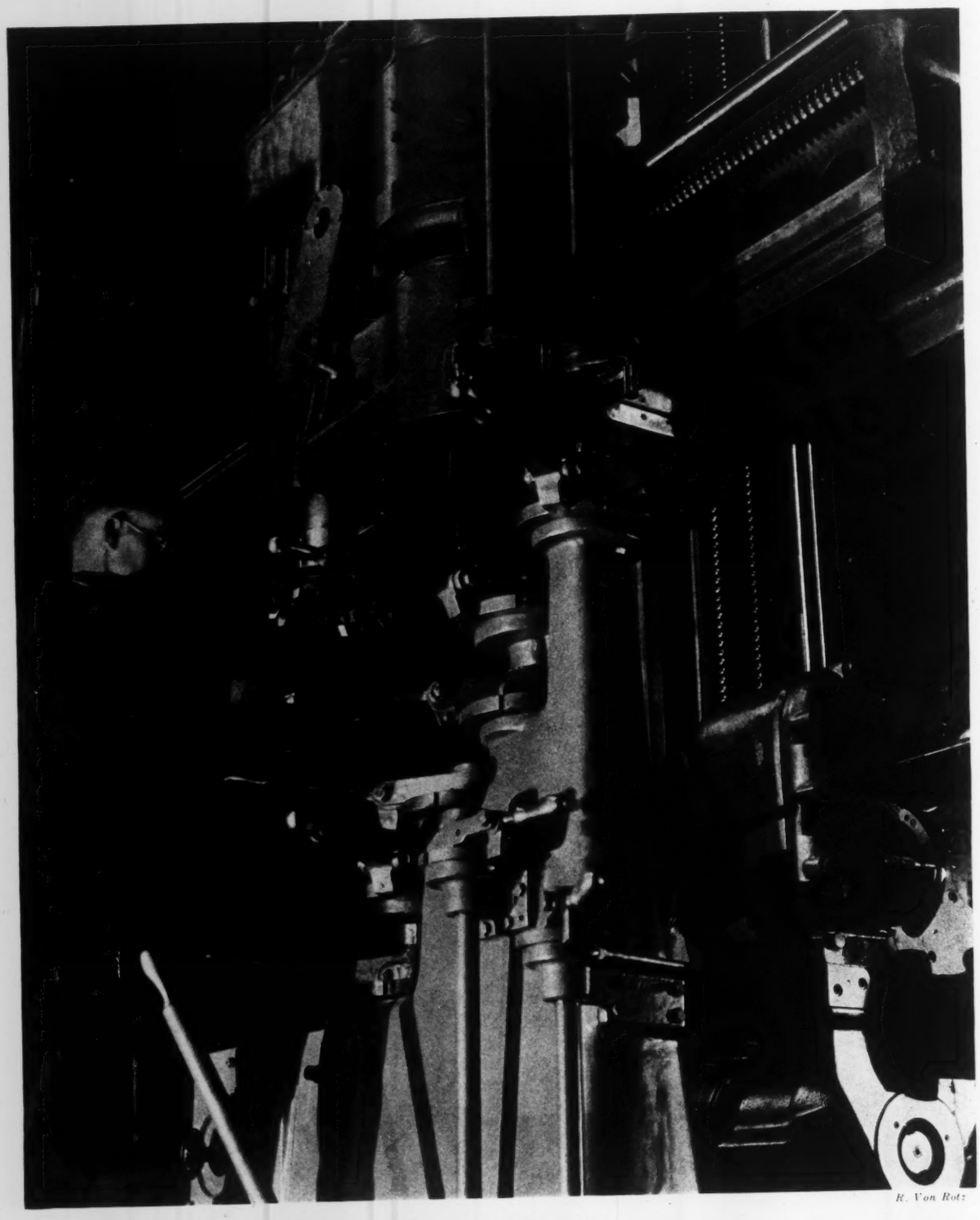

R. Von Rotz

Machine Controls

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MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

Ambrose Swasey

AMBROSE SWASEY, past-president and honorary member, The American Society of Mechanical Engineers, founder of the Engineering Foundation, died at his summer home in Exeter, N. H., on June 15, 1937. A tribute that succinctly expresses the life and character of the man was prepared for the dinner in his honor on Dec. 2, 1936, when the Hoover Gold Medal was presented to him, and from which the following is quoted:

Mr. Swasey represents the Yankee mechanic brought to its fairest flower and fullest fruit. In a machine shop in Exeter, New Hampshire, he first disciplined his native skill in precise and resourceful craftsmanship. Here he met his partner of mature years, Worcester Reed Warner, with whom, in 1869, he went to Hartford, Connecticut, where, in that famous training school of machine-tool builders and precision manufacturers, he completed the period of his life during which he labored under the direction of others and from which he departed with Warner in 1880 to form a long and fruitful partnership, the Warner and Swasey Company, of Cleveland, Ohio.

Into the products of this partnership, machine tools and the structural parts of astronomical instruments, including many of the world's finest and largest telescopes, was put the ingenuity of correct design, the precision of skilled craftsmanship, and the practicability of everyday use that have made and sustained the reputations of the famous founders.

As technical success and material prosperity crowned honest and intelligent labor, Mr. Swasey grew in moral and spiritual stature and extended his influence and personality into a long life of distinguished services to the industry in which he worked, to engineering, to science, to research, to his church, to education, and to public affairs. With all of these he shared his fortune as well as his intellect and the vigor of his personality. In 1914 he established the Engineering Foundation, to which his personal contributions to date have amounted to more than half a million. In this gift alone he has made permanent his influence to future generations.

For ninety years Mr. Swasey's capacity for friendship and the engaging qualities of his personality have endeared him to men in all walks of life. The list of his honors is long and impressive, but on it is none that describes him so well as that bestowed by a group of personal friends that included John Brashear and John R. Freeman—Knight of the Kindly Heart.

Marine-Diesel Quarter Century

AN ATTRACTIVE brochure by Johannes Lehmann, published by Burmeister & Wain, Copenhagen, reminds us that on February 17, 1912, twenty-five years ago, the first motorship, *Selandia*, was delivered to the East Asiatic Company.

Burmeister & Wain acquired the patent rights to the Diesel engine early in January, 1898, and immediately began to develop this new type of prime mover, but it was not until December, 1910, that the first contract was closed for the building of an ocean-going motorship with two eight-cylinder Diesel engines of 1250 hp each. Good luck and great enthsuiasm attended the initial trials and the maiden voyage of 22,000 miles to Bangkok and return, and measurements of fuel consumption showed it to be 0.363 lb per hp including all fuel used for the auxiliary engines. Today, it is said, the only noteworthy delay has been 10 days in port. During these 25 years the *Selandia* has completed 55 round trips of 22,000 nautical miles each, a total distance equivalent to three round trips to the moon.

But great as the distance traveled by the *Selandia* has been, even greater distances, in another meaning of the term, have been traveled in the development of the Diesel engine. For today the world's motor tonnage has increased to 11,900,000 gross tons; and a modern Diesel for a ship of the *Selandia's* dimensions "could be fitted into a far smaller engine room, it would weigh 30 per cent less, yield 44 per cent more power, and give the vessel a speed 32 per cent greater than the engine of 1912."

Moreover, the apathy and opposition which early proponents of the Diesel engine experienced twenty-five years ago has been replaced by a widespread popular enthusiasm and faith. Wherever steam or other types of internal-combustion engines have been used the Diesel engine has entered as an active competitor. In some cases it has practically usurped the field; in others its superiority, and even its practicability, has yet to be demonstrated.

What will the next twenty-five years demonstrate? Competition begets competition. A promising new development sooner or later finds its triumphs menaced by another newcomer and its older competitors revitalized under the spur of the very threat to their obsolescence. If it were not so there would be little progress and few jobs for engineers.

An active and enthusiastic group of American Engi-

neers who comprise the Oil and Gas Power Division of The American Society of Mechanical Engineers, which holds its annual meeting next monrh at State College as announced on page 554 of this issue, looks back over a history antedating in its progenitor, the Gas Power Section, that of the *Selandia*. Organized in 1908, this lusty forerunner of the Oil and Gas Power Division developed a series of vigorous programs and valuable papers. The present division has maintained this tradition and has added to its activities the compilation annually of the Oil Engine Power Cost Report. As engineering practice has shifted its emphasis from gas to oil power, the division has kept pace with it. Here, as in the case of the *Selandia*, subsequent developments have justified the early faith displayed in new forms of motive power, and the division stands as a notable example of the way in which a group with special interests can thrive in the atmosphere of a great engineering society with a mutual exchange of benefits and prestige.

Detroit "Planned Program" a Success

GENERAL approval was expressed of the "planned program" of the Detroit Semi-Annual Meeting of The American Society of Mechanical Engineers. Although the purpose of this program has been explained many times, it is useful to review it briefly.

Six sessions, one the dinner meeting, comprised the planned program. These sessions were held in the morning or evening and competed with no other scheduled events. All were related to the general subject of the contributions of the automotive industry to other industries. Speakers of national prominence presented general papers of interest to all, supplemented by engineers who discussed more technical matters related to the subject. Many of these more general papers appear in this issue. Attendance was large because members were not asked to choose between simultaneous sessions. The evening events permitted the attendance of many men who could not get away for daytime sessions.

In planning Society meetings it is always a difficult matter to schedule the wealth of material to be presented so that interference of conflicting interests of members is a minimum. Some members want sessions of broad, general, timely interest at which everyone can be present in a single audience. Others must concern themselves with specialized technical subjects and are content if a relatively few persons genuinely interested in profitable discussion can thrash out their points of view in a highly professional atmosphere. The scheme put into effect at Detroit offers one way of gratifying both groups.

While Detroit offered an unusual environment because of the size and importance of the automobile industry, there are certainly enough subjects of timely general interest to serve as a basis for a "planned program" at every meeting. The "keynote" sessions of the twenties were an effort to provide opportunities for general discussions before large audiences, as are also the Towne, Thurston, and Rice lectures. Detroit showed other possibilities that should not go undeveloped.

Four A.S.M.E. Meetings a Year

STARTING in the industrial East, The American Society of Mechanical Engineers has spread out over the entire country until today its members are geographically widely scattered although professionally they are closely knit together. While this national membership endows the Society with nationwide influence and prestige, it raises organizational problems that give its officers and committees perplexing tasks to perform. Modern means of communication and transportation make it possible for the officers to keep in touch with the sections if the sections cannot easily come to headquarters, and regional districting, with assignment of a senior councilor to each district, group conferences of local section delegates, and a group-delegate's conference annually in New York assist in maintaining unity of purpose and action.

But in spite of modern speed in travel which makes it possible to dine in Los Angeles today and in New York tomorrow, restrictions of purse and time away from business require a planned scheduling of national meetings so that every member may attend at least one a year without too great expense. As a step in such planning the Council of the Society, at the recommendation of the Committee on Meetings and Program, has authorized four national meetings a year. The plan proposes the holding of an annual meeting in New York (an annual business meeting in New York is required by law), a meeting every year in the industrial Middle West and in the Rocky Mountain or Pacific Coast areas, and, on alternate years, a meeting in New England or the South. Each is to be a meeting national in scope and importance. The coming twelve-month period, for example, provides a Fall Meeting at Erie, Pa., early in October, the Annual Meeting in New York in December, a Spring Meeting in Los Angeles in March, and the Semi-Annual Meeting in St. Louis in June.

A collateral advantage of the four-meetings-a-year plan will be the relief of the congested programs of the present Annual and Semi-Annual Meetings. By proper scheduling of papers available for presentation, it should be possible to reduce materially the confusion and dissatisfaction that result from the many simultaneous sessions that now swell the technical programs of Society meetings.

National meetings of the professional divisions, at which intensive programs on restricted phases of subject matter are presented, are still fulfilling the purpose for which they were designed, and that these gatherings are not being abandoned is amply proved by reference to the list scheduled for the coming months to be found on page 559. Divisions holding these national meetings of their own members contribute also to the programs of the four Society meetings and thus expand their activities as the occasion and amount of material available for presentation demand. These are evidences of healthy growth in technology, and of the manner in which the Society attempts to keep its programs and its members abreast of that growth.

AN OLD GRIST MILL ON THE ROUGE RIVER WHERE MR. FORD'S EXPERIMENTS IN DECENTRALIZATION BEGAN IN 1918

DECENTRALIZATION *of* INDUSTRY

By W. J. CAMERON

FORD MOTOR COMPANY, DEARBORN, MICH.

DECENTRALIZATION is not a new phenomenon. Something like it is continuous throughout life and history. We mobilize and disperse; we accumulate and we scatter; we concentrate and we diffuse; and these complementary or compensatory movements seem to govern human progress as the diastolic and systolic action of the heart governs the circulation of the blood. Gathering and pressing out, accumulating and distributing, with always the centralizing principle in the lead, mark you, the other inevitably following. We seem now to be in a period of systole, a period of contraction that is forcing centralized values out. In the personal world, we have seen a great swarming of foreign peoples back to their original homes. There has also been a great swarming from the cities back to the farms and smaller towns. It is astonishing to learn the extent of the emigration from our large centers of population during the last seven years. This movement is always going on, though the fact is often unobserved and its meaning is often lost upon us, because of our preoccupation with other things.

On one point concerning this we may be very clear, however; it is not a meaningless shifting back and forth of constant elements. It is not like carrying a pile of coal to one place and then carrying the same coal back again. The elements that are capable of being decentralized are not quite the same elements that were first conglomerated or that were first developed and differentiated in a mass process. We can see this illustrated in the great march that was made upon our cities from the rural districts and in the great American immigration from foreign lands. Drawn to cities like Detroit, or Flint, or Pontiac by the lure of high wages, multitudes have come from the hills and countryside of all parts of our land—principally, one may say, from the backward parts of our land—and have undergone the discipline of city living and industrial cooperation. In the cities, they have learned the art of living together in sanitary and healthful surroundings; in the shops, they have learned the possibilities of coordinated effort. Should conditions arise to make their return necessary or desirable, they take back with them to the hills and the farms and the countryside many of the social and hygienic advantages that city life must develop in order to be possible at all. There is no telling the great advantage that has accrued to far-off country districts by the five or ten year sojourn of hundreds of thousands of their people in the cities. Dean Vaughan, of the University of Michigan college of medicine, used to say that he knew there was plenty of fresh air out in the country, because all the bad air was shut up in the farmers' houses. That is not so true now as it was when that able and splendid man made the remark. Hundreds of thousands of countrymen, having had their experience of city ways of living, have transplanted them to farms and villages and raised the level. And this has worked in a still wider circle. If you have motored in the backward countries of Europe and have encountered mechanical or other difficulties, you have noticed the total inability of the openmouthed throng around you to make suggestions or do anything. And then it has happened, as many an American motorist can testify, that a

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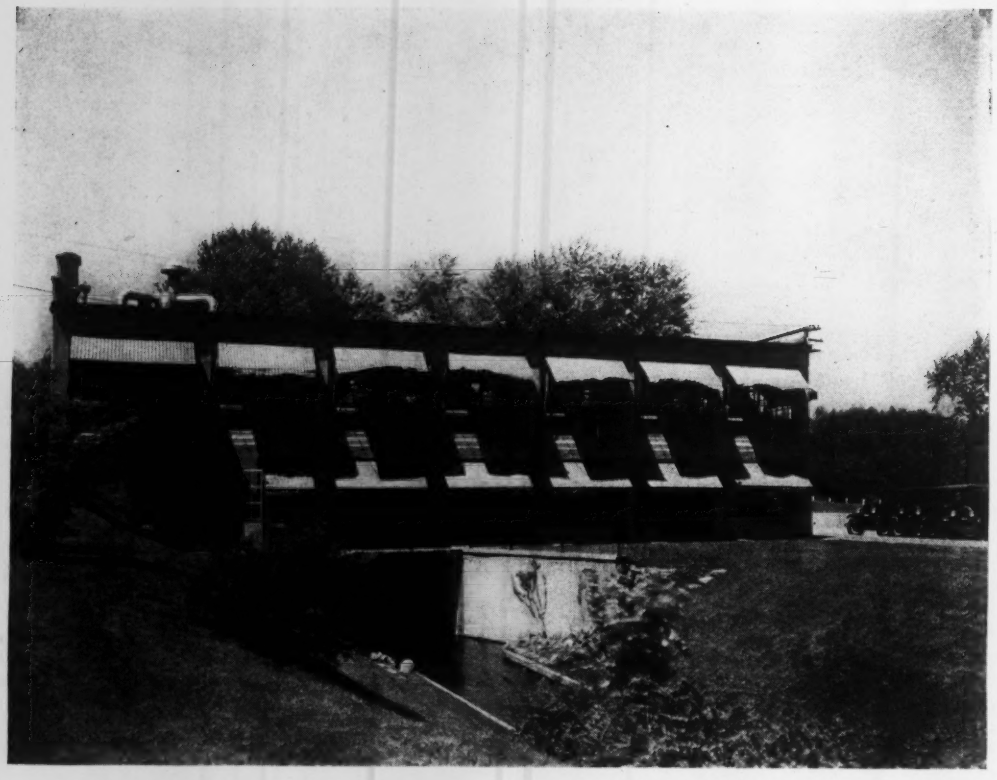


ONE OF MR. FORD'S OBJECTS IS TO SHOW HOW SMALL A STREAM CAN BE PROFITABLY USED FOR INDUSTRIAL PURPOSES—THE PLYMOUTH PLANT

man has emerged from the crowd, a man very much like the rest but with a certain power of initiative and a certain air of mastery, and has given the necessary help or advice. You ask who this man is that seems so different from the rest; seven times out of ten, you discover that he has lived in America; sometimes, he has worked in the very shop that built your car; he knows your city and your ways and has learned the trick of tackling a problem; he took back with him from America something that you fondly believe will make a tremendous difference in that community. So that the thing that is thrust out, the thing that is decentralized, is never exactly the same thing that was centralized. Something meanwhile has happened to it, changed it, made it competent to live alone far from its source.

MASS PRODUCTION MAKES DECENTRALIZATION POSSIBLE

It is much the same with what we call the decentralization of industry. That which we can decentralize is much different from that which was first massed together. What we have learned in mass production makes decentralization possible. Decentralization is not to be thought of as correcting a mistake that was made in developing mass production; it is to be thought of as being made possible by our experience in mass production. If we think of it as repairing a serious error in judgment, rather than as a logical development of industrial experience, we start from a wrong point. Both movements are justified. Congregating to a center has the advantage of coordinating many parts into a cooperative whole; disseminating them again possesses the advantage of bringing them to further refinement as separate units. Both movements must be looked upon as parts of one whole, a progressive whole. Both are as natural and beneficial as ebb and flow.

Now, we are speaking about the decentralization of industry, and I must confess that the first discovery we make is that we are discussing something that as yet hardly exists in practice; it seems rather to be just an idea floating around in the air. I have looked as carefully and as far as I can for signs of the thing itself, and very few are to be found. To be sure, a certain restless moving to and fro is always going on in business. In one year, something over 200 businesses left Detroit alone, and, everywhere else, businesses can be found on the move, for one reason or another. They move to escape being confiscated by local tax collectors; they move because of the open hostility of local government; they move because a town has become infected with that peculiar form of social, political, or unionistic philosophy which confuses progress with the persecution of industry; they move because the population of certain places plainly indicate that they will not accord industry the rights and protection under the law which are enjoyed by other citizens. Whole communities have found and are finding their entire setup changed by these causes. What I want to point out is that this is not decentralization. It is necessary to make a sharp distinction between decentralization and mere change of location. Likewise, to move a factory to the South or anywhere else, to take advantage of lower wage conditions is not to be confused with decentralization.

Decentralization means taking away a part or parts of a large organization and setting these separated parts in another place to operate independently. This presupposes a very considerable degree of centralization in the first instance, which, for good and sufficient reasons, is afterward broken into here and there for the separation and removal to other localities of certain departments susceptible to this form of treatment.

Thus, we cannot say that branch factories are examples of decentralization. Most large companies have branches in various states and in Canada, but these are really new regional centralizations. The decentralization we speak of really begins where this branch movement leaves off.

FOR THE SMALL FACTORY NOISE AND STRAIN ARE REDUCED TO A MINIMUM—THE WATERFORD PLANT

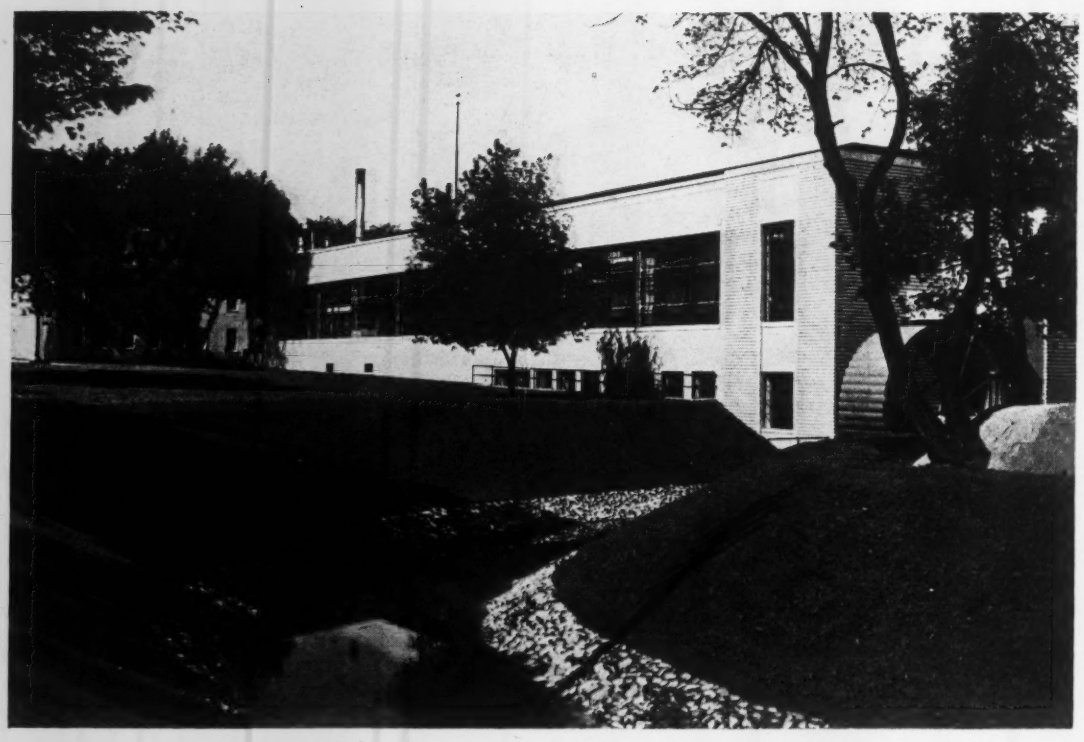
FORD'S SMALL PLANTS A STRIKING EXAMPLE OF DECENTRALIZATION

I regret that I cannot illustrate what I mean by instances outside the Ford Motor Company, but, so far as I know, decentralization is not notably illustrated elsewhere at present; and I gather that it was the intention of those who invited me that I should tell the Ford experience. It is now 20 years since Mr. Ford actively engaged in the decentralizing experiment. I might also say, personally engaged, for everything from the selection of the site to the superintendence of the erection of the plant and all that came after have always had his most personal attention. Perhaps, one reason decentralization has not been more widely practiced is that it does require so much personal attention. The idea originally came to Mr. Ford in his frequent drives through the country, as he passed the places where the early settlers established their little mills run by water power. He has a very high respect for the ability of those settlers to pick the right spot. His first experiment began in 1918 with an old gristmill known as Nankin Mills situated on the Rouge River, and you who know the Rouge in its upper reaches know that it is not much of a river. Since that time, he has established eight industries along the Rouge, industries that range from 15 to 400 employees; most of them are housed in modern plants, which, instead of bringing a clashing industrial note to the countryside, fit harmoniously with the landscape. These little village and country industries are really things of beauty. There are also three plants located on the Huron River and four on the Raisin River, the latter being a small and unimportant stream. One of Mr. Ford's purposes is to show how small a stream can be profitably utilized for industrial purposes.

In all, 25 plants are included in our decentralization program, four of which are rather too large to be called village industries, and nine of which are in various stages of completion. Thirteen small plants are now in operation within a radius of 50 miles of Detroit. They make a variety of things, such as welding points, lamps, drills, valves, taps, generators, starter switches, and similiar light products. One plant is operated entirely by 94 women, who assemble cutouts and stop-light switches. Another plant is devoted to making the Johansson gages. All of these plants are easily accessible from Dearborn; stock is distributed by trucks, and the finished product brought to the main assembly by the same means. Four of these plants are established in rehabilitated grist mills, at least one of which is 100 years old, and all of them are in rather romantic surroundings. Better than any description I could give of these plants would be seeing them for yourselves. An afternoon would suffice to give you a bird's-eye view of the general scheme, and I am sure the company would offer you every facility to examine its work as carefully as you wished.

UTILITARIAN AND HUMANITARIAN ASPECTS

What started all this? I am trying to tell the story in as factual a manner as I can. I could say, of course, that Mr. Ford's motive was humanitarian, that he wanted to provide a way by which people could leave the congested industrial districts and live and work in the country, enjoying for themselves and their families all the advantages of village and country life with a city income. And if I said that, it would be true, but not the whole truth. I remember a very high-minded and zealous social reformer exclaiming at the clear light and cleanliness of the Ford factory and trying to get Mr. Ford to admit that he had insisted on plenty of light because it was more healthful. "No," said Mr. Ford, "we have plenty of light because you can set machines closer and put more in the same space." "But," the visitor insisted, "the men's health and eyes you know, cheerfulness, brightness," etc., etc. "Yes," said Mr. Ford, "but it saves space; the more light you have, the more space you can use, no dark corners." And that is all the visitor could get out of him. The utilitarian seemed to



VILLAGE AND COUNTRY INDUSTRIES ARE REALLY THINGS OF BEAUTY—THE PLANT AT NORTHVILLE

blot out the humanitarian completely. It completely spoiled a very nice philanthropic picture, and, of course, Mr. Ford would spoil a picture of himself as a philanthropist any day. So in this matter of small industries in the country, decentralized from the big industry, the motives were mixed. Which came first, who can say? There was interest in water-power development, in economical operation, in the human element, and all of these being right, all of them turned out right; but it is a question whether they would have dovetailed so well if the main motive had been sentimental instead of practical. Anything that is practical and workable usually turns out to be humanly and socially beneficial too, whereas, starting out with only the humane motive does not always guarantee that the plan will eventuate in a practical and self-sustaining result. I think the natural history of the idea in Mr. Ford's mind was probably this: First, a belief in the economy of water power; second, a desire to demonstrate the utility of small streams; third, a belief that industrial and social advantages would follow.

I have already indicated the number and character of the plants in which this idea has, thus far, incarnated itself. It remains only to indicate some of the advantages we have found in it. There is no executive of the Ford Motor Company and no one directly connected with these country industries who is not very enthusiastic over the results obtained from this experiment.

From the employee's side the advantages are obvious. He works in a small factory where noise and strain are reduced to the minimum. He lives in an American village—the best place on earth to live—or on a plot of land near the village. His family have the advantage of the clearer air, the more natural tempo of life, the rather higher level of neighborhood character usually found in such places. He is within an hour and a half of the big city. He probably indulges a propensity for gardens and chickens which supply some of his needs and lighten the pull on his income. His work is likely to be steadier, for various reasons which the production man will understand. And altogether, the problem that we have to deal with is the large number of men who are constantly beseiging us for jobs in these village industries. At present, we have only places enough for about 4000 of them. But it is safe to say they are our 4000 best satisfied employees.

ADVANTAGES ACCRUING TO INDUSTRY FROM DECENTRALIZATION

As to the advantages accruing to the industry itself, they are equally definite. We think that we can say that much better work is done in these village plants than in any others we have. We find that a small department or even a fairly large one, as at Ypsilanti, segregated in its own locality, develops a pride and a skill that seem impossible when that department is part of a vast central factory combining many departments, impinging one upon the other. The men have greater interest in their work, because they have a clearer view of it. They lose less time on their own account. The labor turnover is slight. They, themselves, improve the job they work upon. The supervisor has just one job to do; he can concentrate on that, experiment with various methods, and the results he achieves are often remarkable. Minute and money costs have diminished in a way that proves economy right up to the hilt. Of course, these plants pay standard Ford wages throughout; each is required to maintain a payroll representing a cross section of the community as to age and the incidence of disability, but, because they have just one thing to do, because they are under supervision that is free from the harassment that is almost inseparable from a big centralized plant, the results, in our case, are without flaw, so far as we can see. It is one of the most all-around satisfactory things Mr. Ford has done. It has the advantage also of a closer relationship between men and management, a relationship that was so regrettably lost as our mass-production plants grew larger and larger. Overhead is less, even when the full share of overhead of the central plant is added. Altogether, it will bear investigation

by all those who are in the position to make this experiment.

Of course, actual decentralization in a large sense has not yet come. What we have done amounts only to a small-scale experiment. I dare say we shall see it advance to larger scale in the future. Many influences are forcing its consideration. Centralization will always exist, in so far as the heavier operations of industry are concerned, but, in the contributory departments, we may see decentralization proceed more rapidly than in the past. It is simply a matter of an industry that is large enough and has sufficient reasons for the step, studying what departments or what operations could be advantageously set up in a country building of its own, by some water power preferably (although we have used steam with equally good results); and then carefully removing that operation or department and watching what the mere act of removal and separate supervision accomplishes. As I said in the beginning, this requires considerable personal attention, and management is not eager to add to its already heavy burdens. It requires a motive born of a vision, the following of which is its own pleasure and reward. I believe that much of this is ready to make its appearance in industry. It is apparent to every one that the point which we have reached is far from finality. Events have shaken us out of any complacency we may have had and are forcing us to resume the laborious march of progress; that is, certain phases of progress that in the pressure of making things we have neglected. Congested masses of humanity in our great industrial centers constitute a blot on progress. They also, too often, prove the breeding spot of social disruption which no amount of technical progress can counterbalance. It was necessary that these great armies assemble and solve the problems of mass production, but that is now largely accomplished. We have learned so much in this field, which we can now use in decentralized production, that the time seems to have come for moving it out where life can be lived on better terms for the worker. Mass production was not and is not a mistake, and decentralization will not affect its advantages in the least, but, as practiced in one central spot, it was only a step in the process. To many of us, some degree of decentralization seems to be the immediate next step. At any rate, our experience with it is open and welcome for anyone to examine.

INDUSTRY—THE GREAT REFORMER AND LIBERATOR

I close with a remark with which I have been trying to inoculate American businessmen for some months past. From my reading of industrial history, I have reached the conclusion that no industrial advance of social importance has ever come from any source except industry itself. All great advances and improvements in hours, wages, working conditions, safety, or any other thing in which industry affects life, have come, not as the result of outside pressure upon industry but as the result of the inside pressure of industry upon its problems. The air is full today of strange misreadings of industrial history in this respect. Reforms, which all documents and records show to have been a great victory of industry over the moral and mental inertia of society, are described as a great victory of society over industry. I have been anxious for businessmen, who mostly take their opinions on these matters secondhand, to be emancipated from the deluge of falsity that has made them the enemies of social advance, instead of what they really are, instead of what industrial history proves them to be—the originators of most social reforms of the last century and a half and of all the industrial reforms. Industry has been the greatest of reformers and liberators and leaders that civilization has had these 150 years. We have spent 30 minutes tonight speaking about industrial decentralization. Where did that idea come from? From any labor leader? From any politician? From any professional reformer? It came from within industry itself—industry thinking upon its own problems. It has always been that way, it will continue to be that way. For we certainly cannot forget one thing, namely, that, while we are making things of use, we are also making human life and the conditions of human society; and the better we make things, the better we must make conditions to make things better; and, thus, we start an endless chain from which no part of life can be excluded.

A SMALL DEPARTMENT, SEGREGATED IN ITS OWN LOCALITY, DEVELOPS PRIDE AND SKILL—WORKERS AT NORTHVILLE PLANT

AUTOMOTIVE CONTRIBUTIONS *to Other* INDUSTRIES

By C. F. HIRSHFELD

CHIEF OF RESEARCH, THE DETROIT EDISON COMPANY

IT IS my pleasant duty to explain to you certain features of the program which has been prepared for you, to orient you in order that you may obtain the maximum benefit from your participation.

The committee in charge of the program developed certain rather clear-cut specifications. It conceived the idea of regarding it as a well-knit structure concentrating on a certain theme and broken into two major parts. The first of these consists of the general sessions, held in the mornings and evenings and available to every one because of lack of conflict with other scheduled meetings. The second part is taken care of by afternoon sessions. These are simultaneous in character and under the auspices of the different professional divisions.

We of Detroit are just a little proud of certain phases of our engineering and industrial development, and we think we are justified in our pride. We believe this community has exerted a very definite and beneficial leadership in the evolution of many admirable features of modern industry. We believe we have put into practice, and proved to a great extent, rather novel principles of great human worth. We believe we have indicated to a measurable degree the paths to be followed by industry in advancing toward the maximum of both economic and social values.

Your committee felt that the activities underlying such beliefs would form an acceptable and appreciated central theme. It thought the general sessions might well be devoted to a series of addresses and papers which would stress the technical, the economic, and the social significances of our local industrial methods and viewpoints.

It believed, also, that the treatment of the central theme should be not only general in concept but also specific in development. If you will look over the addresses and papers that are scheduled for presentation at these sessions, you will appreciate how this has been attempted. They are designed to feature the automotive and allied industries centering in Detroit, and the mass-production methods used in Detroit, their contributions to other industries such as railroading, and their influence upon life and work in the United States. The programs of the simultaneous sessions have been designed to give details supporting the broader pictures painted in the general sessions as well as to provide opportunity for the usual professional-division activities.

In addition to all this, arrangements have been made for inspection tours that will afford opportunities to see at firsthand many of the activities referred to in the various papers. The inspection tours are divided roughly into two classes, those of very general and those of more specialized interest. The tours of general interest are scheduled in so far as possible for Monday afternoon and for Friday morning and afternoon. This arrangement is intended to make these tours of maximum availability.

Presented at the Semi-Annual Meeting, Detroit, Mich, May 17–21, 1937, of The American Society of Mechanical Engineers.

Returning now to our central theme, the methods and significance of the automotive industry, I ask you to recall what a comparative infant this industry is. The turn of the century saw it in swaddling clothes. I recall most vividly the "horseless carriages" of that day and the adventure of a trip beyond the urban pavements. Undoubtedly, many of you can still remember the derisive "Get a horse" which greeted the adventurous but unfortunate soul who placed his faith in these early vehicles. And yet, in the short space of a third of a century, this infant has grown to a most extensive and astounding industry. The "one-lunger" of hiccupy activity and uncertain temperament has given place successively to improved models until now the automotive vehicle represents one of the smoothest and surest mechanical appliances yet produced by man. It has changed in revolutionary fashion both the character and the tempo of human life. It has brought with it a whole train of new activities, new services, new social concepts, new accomplishments. Viewed historically, I think it will be counted one of the major developments of the race, like the steam engine and the spinning jenny.

The manufacture of automotive equipment is recognized as one of the finest examples of mass production. So much attention has been concentrated on this aspect as to tend to obscure others of much deeper significance. Living in the middle of the industry as I have, and yet watching its development as an outsider, has given me ample opportunity to philosophize about it. I have studied it in comparison with the other industries that I know more or less about. I have endeavored to evolve conscious mental concepts and then to put into words the striking and different characteristics of the driving spirit of this lusty youngster. I shall endeavor to give you in a few words the results of my efforts for what they may be worth. I labor under some difficulty in doing this because we are dealing with an ever-evolving thing, whereas I must speak as of a certain definite instant.

My first observation is that this industry has been, and still is, guided by men of tremendous courage and with perseverance verging toward obstinancy. The phrase "it cannot be done" is replaced with the much more fruitful one "it must be done." Many of these men have gone down to defeat; the mortality has been high. On the other hand, those who have survived can look upon a glorious accomplishment.

My second observation is that these men have reversed a very general industrial procedure. In most industries, a design has been produced. It has then been priced, and the selling price was the last figure to be obtained. Here we have an exactly opposite procedure. A selling price and what is to be sold at that price are first determined. Then those charged with design and production are given the task of producing at that price and within those rather exacting specifications. Again, it is a case of "it must be done." And the industry has use only for those who can do it.

My third observation is that out of the character of the lead-

ers with their "must be done" slogan and out of the practice of pricing first and then meeting the price have developed all those advances in production technology for which the industry is famous.

My fourth observation is that this industry recognized at a comparatively early date that its wage earners must also be its customers. The result is a philosophy of high hourly wage with a sufficient output per man-hour to justify the payment of this wage.

My fifth observation is that these leaders have reversed another very common industrial procedure. It has been a common practice of industry to develop a design and then to continue its production without major change as long as possible. In this way, all expended effort and capital were conserved. In the automotive industry, we have an opposite procedure. Here is an industry that consciously and intentionally obsoletes its own product and, thereby, discards much of the effort that has been expended in producing it and much of the capital goods acquired for producing it. Improvement, novelty, and advance are the watchwords, not conservation. Other industries are now copying this method, partly because it has been found to pay, partly as a means of surviving under competition, and partly through the urge for continued life exhibited by newly born technological infants.

Let us look for a few minutes at some of the material advances that have resulted from this rather striking combination of characteristics. You all know the motor car started as a luxury product. The first task was to make something that would run and hold together with reasonable repairs for a few thousand miles. The pioneers started with bicycle tires; with the wood, the cast iron, the malleable iron, and the steel of that day; with embryonic forms of internal-combustion engines; with the simple machine tools and the skilled mechanics of 40 years ago. If those of you who are old enough will but think back to the beginning of this century, you should be able to recall the conditions I describe. The younger members of my audience cannot possibly appreciate them as existing such a short time back.

THE AUTOMOTIVE INDUSTRY AND METALLURGY

One of the early discoveries was the inadequacy of the metals then available. First came heat-treatment. I well remember the tremendous significance of the first advertisement of a forged and heat-treated front axle. Next came alloy steel with all that means to present-day industry. If you want a mental jolt, find a mechanical engineers' handbook published about 1900 and compare the section on iron and steel and heat-treatment with that contained in one published within the last few years or with a copy of the "S.A.E. Handbook." I know of no better way of visualizing the enormous advance that has occurred and which is, at least in large measure, attributable to the automotive industry. Personally, I have no difficulty in obtaining such a picture. I graduated from an engineering course before all this knowledge was available, and I have been working overtime ever since in a futile effort to keep up with the procession.

I wish I could describe adequately the casting problems of the early builders of gasoline engines. Even with the large cylinders then in use, few founders knew how to produce single cylinders with integral valve chambers and integral water jackets. Many builders had to resort to copper jackets and other complicated constructions. Picture that, and then look at the intricacies of the modern multicylinder blocks with their beautifully uniform thin sections and made of special irons meeting rigid specifications. And then realize that these castings, so impossible only a few years ago, are produced continuously in huge quantities and with the minimum of rejects. It is easy to say in words; it was difficult to accomplish in fact. But, because it was accomplished, many other industries today may avail themselves of casting practices and methods that certainly would not have been developed so rapidly had it not been for the automotive industry.

As another interesting diversion, I suggest that you collect pictures of automobiles as they have been made through the years and compare them with pictures of modern cars. You will observe a gradual transition from plane surfaces, through flat curves and then deeper curves to full molded shapes. In one sense, this represents an evolution of style, an ever-growing appreciation of the correct shape and form for an automotive body. But, back of it stand tremendous advances in the art of deep-drawing steel sheets and of welding thin gages. And back of this, stands a monumental improvement in the making and rolling of steel to thin gages of uniform thickness, with relatively perfect surface finish and internal structure, and of great width. The present very general use of deep drawing and welding as a means of fabrication in many of the other industries may be said to rest upon these developments that have been made by the automotive industry.

One might also mention the evolution of gearing with reference to designs, materials, cutting, and heat-treatment. This is a huge and interesting story worthy of a whole book. The transition from noisy gears with lives of a few hundred or a few thousand miles to the quiet gearing of the present day, not only still usable after 100,000 miles or more but also, even then, quieter than the average product of 20 years ago, is indeed an accomplishment. And it has set a new standard for gearing in other industries as well as providing the means for meeting that standard.

Wonderful and significant as are all these metallurgical accomplishments, they are, in my mind, eclipsed by one other. This may be because of early training. It happens that much of my early experience concentrated my attention upon cranks and crankshafts, and I well remember the many admonitions of my superiors with respect to the character of metal and the quality of forging required. And then one day, I was shocked into the realization that I had something else to relearn when I discovered that one automobile manufacturer had standardized on a cast-alloy crankshaft which is in reality a sort of semisteel. Where this may lead, nobody knows, but it certainly provides food for thought. It may mean that, before we have finished with this very recent development, we shall find ourselves completely changing our notions with regard to the value and availability of cast parts.

CHARACTERISTICS OF MASS PRODUCTION

One of the characteristics of mass production is a studied and well-developed system of intrafactory transportation. Such production is not possible without an orderly flow of components, subassemblies, and final assemblies. It is true that conveyor equipment of various and ingenious sorts was in use before there was any automotive industry, and it is also true that such equipment was developed to a highly specialized degree in other cases, for example, the packing industry. But it is a fact that the mass production of the automobile served to concentrate upon the conveying problem many of the best engineering brains of the country, so that now we have huge corps of specialists and a well-developed, highly specialized field of knowledge and practice available for the solution of problems that may arise in many other manufacturing and handling activities.

Another of the characteristics of mass production is the absolute necessity for interchangeability of parts. The hand-fitted

product of the older industries is economically impossible in mass production. Selective assembly, of more recent genesis, is also impossible when numbers become sufficiently great. Thus, real mass production leads to the careful study and the use of tolerances, to jigs and fixtures, and to gages for the inspection of parts. To the young industrial engineer of today, tolerances, jigs and fixtures, and gages are but natural concomitants of manufacturing processes. It might surprise such men to know that when we began making munitions for the late World War, it was difficult indeed to find plants and individuals accustomed to the use of tolerances and of gages with which to check them. Even the automotive industry was not as well-developed in this respect as one would now suppose and yet it stood head and shoulders over most of the others. Today it is unusual to see a drawing which does not indicate tolerances on the more significant dimensions. In those days comparatively few drawings were thus embellished. When I studied machine design they did not even teach tolerances although, to do my instructors justice, they did have a bit to say about pressed fits and running fits.

To my mind, one of the great and enlightening achievements of automotive engineers is the intraindustry standardization and the research, negotiation, and compromise that lie behind it. Here are men who realize the throttling effect of standardization if carried too far but who also realize the economic value of standardization carried far enough. I am not prepared to say that this intraindustry standardization is responsible for the very general standardization work of the present day. In fact, I do not believe it is wholly responsible. But I do know that this industry has standardized most effectively and most expeditiously with the result that S.A.E. Standards are now very generally specified and used in other industries. I think this is but another result of the "it must be done" principle of operation.

We should not forget the effect of this industry on protective coatings of all sorts, including plating and painting. Several comparatively cheap rust-resisting finishes have been produced and used extensively; nickel-plating has been carried far beyond earlier accomplishment; chromium and cadmium plating have been made real servants of industry. Perhaps the most striking development is that of the synthetic lacquers and the new types of paints that followed. It is true that synthetic lacquer was developed independently and that its existence was merely discovered by the automobile builder. But it is equally true that the latter is largely responsible for its widespread use, its rapid improvement, and the ensuing production of all sorts of new pigment finishes.

IMPORTANCE OF EFFICIENT PROCUREMENT AND SCHEDULING

The assembly at a plant of all the raw and semifinished material, all the parts, and all the supplies required for the production of automobiles at present rates is no mean problem. Failure to receive any one of thousands of different things would mean partial or complete shutdown of a tremendously expensive collection of facilities, would mean disrupted working forces, and might easily lead to loss of market. On the other hand, any great extent of storage of materials and components is practically impossible just as is any adequate storage of finished vehicles. Everything in this industry is dynamic, not static. There may be changes of pace, there may not be cessations of flow except at times when complete shutdown is planned.

These features have led to very elaborate and very effective procurement and scheduling organizations, upon the smooth functioning of which rests the success of the industry. Probably the greatest achievement in this line is an arrangement for estimating the day-to-day and week-to-week sales possibilities, and accompanying provisions for controlling delivery of materials and parts and the production of finished vehicles. The width of the main stream and the widths of all contributing streams are controlled from day to day, as required, to deliver what the market will take. It is a difficult way in which to do business but one that is profitable to both the producer and the consumer.

It is obvious that no business producing at the rate characteristic of this industry could be successful if it did not provide adequately for the distribution of its product. I use distribution here in two senses. First, the product must be carried away from the plant, and, second, it must be sold to the public. The transportation from the plant is no mean problem. As you know, it has been solved by using special boxcars, special motor trucks and by "driveaways." Scheduling of such deliveries and provision of the necessary instrumentalities has become a fine art which has had its influence upon the railroads and upon other industries.

Out of this problem of distribution, grew the so-called assembly plant. When the volume of business in a certain geographical area becomes sufficiently great, it may be profitable to establish a local assembly plant which receives easily and cheaply shipped components and assembles them into finished vehicles for comparatively local delivery. Decentralization to this extent has resulted in lower prices to the consumer in many cases.

Many of the early automobile builders met with business failure in spite of technical success. In many cases, too close a financial tie between production and sale to the public was responsible. It was soon discovered that manufacturing is a business by itself, and selling and collecting on sales an entirely different one. Out of this discovery grew many diverse schemes for divorcing the marketing of the factory product from the sale of that product to the public. The present forms of distributing organizations are the result. If one may judge from external appearances, many other mass-production industries catering to individual purchasers are adopting similar methods.

THE AUTOMOTIVE INDUSTRY'S ECONOMIC AND SOCIAL SIGNIFICANCE

All that I have said thus far has to do with the material side of this industry; the ways in which certain results are accomplished. That is all very interesting and very important, but there is another phase that I think is still more so. Here we have one of the most completely developed mass-production industries. What of its economic and its social significance? It appears to point the way along which a great part of our industrial activity is developing. Does it portend good or evil? Modern industry has served as the excuse upon which radical forms of government and of social organization have been constructed in recent years; forms in which individual initiative and individual opportunity are to be submerged; forms known as the totalitarian state; forms in which all and everything are regimented. Does the growth of mass production drive a nation automatically toward such social structures, or do these new versions of old ideas have other driving forces behind them?

Here one enters upon a most controversial subject; one in which race, birth, religion, temperament, emotion, politics, and other modifying factors tend to make philosophical argument impossible or abortive. The subject is further complicated by the world-wide postwar disturbances and, in this country at least, by a very serious and lengthy depression. Many who have discussed this question in this country in recent years appear either to be unable or to refuse to take a long-

range point of view. They insist that a depression, which was obviously one of the consequences of the World War and which was precipitated by an idiotic expansion of credit, results from overproduction and technological unemployment. They insist that the profit motive which must underlie private ownership of capital goods necessarily leads toward the sacrifice of the worker to the greed of the owner.

There are two ways in which one may study the question dispassionately and with some hope of divesting it of temporary phenomena that tend to mask the basic underlying facts and trends. One might concentrate upon the automotive industry as the outstanding example of mass production, study what has happened in it, and then endeavor to reason from that to the nation's total industry. Or one might take the facts with respect to all industry in this country as it has developed through the years and determine general trends accompanying the general introduction of mass-production methods. The second is, in fact, preferable to the former because many people believe the automotive industry is particularly favored in some way. When one holds it up as an example many retort, "Oh yes, but that is the automotive industry with its huge output and ready market; you cannot argue from that!"

However, for what the facts may be worth, the automotive industry appears to have demonstrated the following:

(1) The available market, within very wide limits, may be pictured as roughly pyramidal or conical in shape with altitude representing price and horizontal sections representing available market. I am inclined to believe that the sides of this figure are not really made of straight lines but of curves so that the size of market increases at a geometrical rate with respect to decrease of price.

(2) The price can be reduced and ever-widening markets can be made available by the judicious but daring use of mass-production methods. This applies not only to such things as special tools and assembly lines but to all things having to do with flow into the factories, operations performed in them, and flow out of them toward and to the ultimate consumer.

(3) Such mass-production methods properly accompanied by managerial skill make it possible to pay an ever-increasing real wage to workers in each different classification.

(4) The net result of all is an ever-increasing number of individuals employed in the industry: in the direct production of automotive equipment; in the industries feeding it its raw and semifinished materials; and in the industries and services centering around the use of automotive equipment.

In 1929, when employment in the automotive industry reached a peak, it employed about 200 times the number it had in 1899, but it turned out about 800 times the number of vehicles. The average selling price per vehicle was, of course, much lower in the later year; but, even when corrected for this, the figures indicate a very great increase in the sales value produced per man-hour. This is what made possible an ever-increasing real wage.

11 IN OTHER INDUSTRIES DEPEND ON 1 AUTOMOBILE WORKER

The significance of the mass-production methods of the automotive industry in still another direction is indicated by the following figures. In 1929, there were slightly less than 450,000 individuals employed in the production of automobiles. But as a result of this production, a total of almost 5,000,000 individuals received employment. The latter figure includes steel makers, garage workers, chauffeurs, road builders, gasoline and oil producers, and a number of others.

These are stubborn facts. We of Detroit know that they are facts because we have taken the trouble to collect and study reliable statistics. We prefer not to base our conclusions upon appearances or expediency. We know how these wage earners in the automotive plants own their homes and what a pride they take in home ownership. We know how they own automobiles and modern household appliances and radios. We know how they educate their children.

One may argue that the wage of capital has been out of proportion to the wage of labor. This may have been true in the case of the relatively small number of companies that has survived a grueling competition. But we must not forget the millions upon millions of dollars that have been lost in other companies that fell by the wayside as this industry was evolved. Now that automotive construction is approaching a more stabilized condition, there is in evidence a tendency toward recognition of the lessened gamble taken by capital and a corresponding tendency to increase further the pay of wage earners at the expense of the wage of capital.

RESULTS OF MECHANIZING INDUSTRIES

If one studies other individual industries in which mechanization has been adopted on a broad scale, the same story appears. The product is relatively cheapened, the real wage is raised, the output is increased many-fold, and many more people are employed. The steel industry serves as an excellent example. It has been extensively mechanized during the first three decades of this century. The man-hours per ton of steel have been reduced unbelievably. But, a larger percentage of the total population is now engaged in steel making than was so engaged at the turn of the century. And the real wages paid these workers are materially higher than they were then. These are all facts which can be verified by statistics collected by the U. S. Bureau of the Census and other reliable organizations.

When we endeavor to carry our investigation beyond the individual industry, we face a problem. Shall we consider only the manufacturing industries, or shall we consider all industry other than agriculture? As a matter of fact mechanization and the resultant swing toward mass production are now characteristic of all our activities including agriculture.

If we consider initially only manufacturing, we find that in the first three decades of this century factory employment increased about 85 per cent while the population increased about 62 per cent. And yet, this is the great period of mechanization. Naturally, some of the increase in factory employment resulted from a partial shift of the agricultural population. But the country as a whole has been better fed as a result of the mechanization of agriculture and the greater real wage of the consumers of agricultural products.

If we consider all industry other than agriculture, we find a slight increase in the percentage of the population gainfully employed during this period but, remembering that the population increased about 62 per cent, this means a very large increase in the total number of job holders. There has been an accompanying increase in real wages. This may be put at any value between approximately 33 per cent and something over 100 per cent, depending upon the method of calculating it.

There is another way of looking at the situation. Our national income has increased over 400 per cent in a period during which our population increased only about 62 per cent. How was this possible? Only through mechanization which enabled one worker to produce more real wealth per hour of toil. According to storybook economics and Santa Claus philosophy, this huge increase in national income has gone into the pockets of a few astute and rapacious individuals. In fact, this income is merely the dollars expression for all of the things that are produced per year. Who uses the shoes, the clothes, the refrigerators, the radios, the food, the houses, the washing machines, the plumbing fixtures, the percolators, the

automobiles, and all the other necessities and luxuries lumped into this expression? Obviously, the mass of the people; the very individuals that produce them.

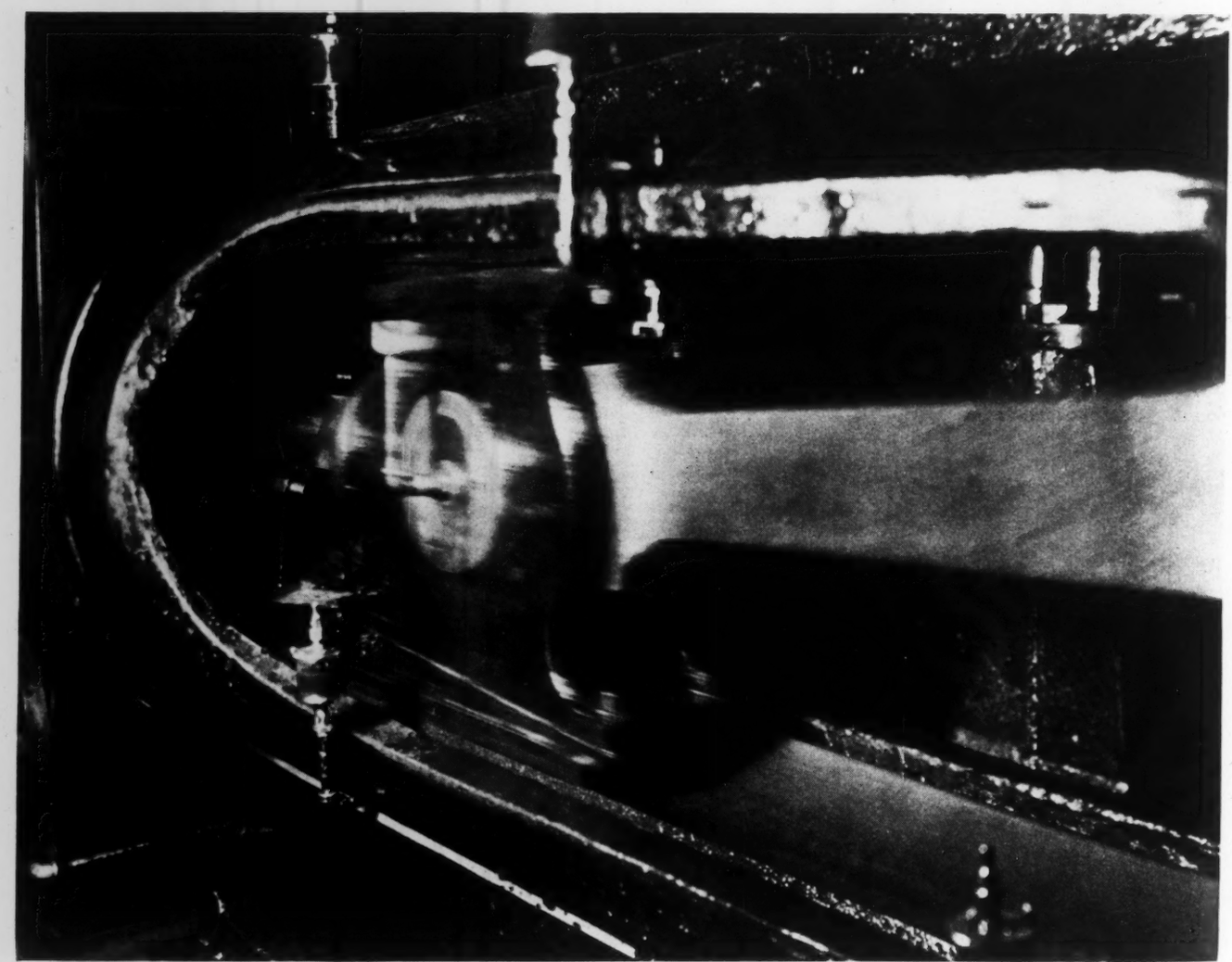
As I see it, this is the significance of mechanization and of mass production. They afford the opportunity through which the wage earner can produce so much more per hour of labor that he can have more to use and to enjoy. And it must not be forgotten that, in the sense in which I use wage earner here, we are all wage earners.

I would not have you understand that I think we have reached, or are approaching, the millenium. There is no doubt that we have gone far toward the improvement of the lot of the great mass of our population. But there do, and probably will, remain for a very long time, many nasty situations and many annoying unsolved and partially solved problems.

I believe firmly in the efficacy of competition in the great bulk of human affairs. And I look askance at the various invitations to inefficiency which characterize all cartel systems and their near relatives. But I recognize that, so long as we remain human beings of the present type, such competitive endeavors can be carried on only through constant bickering, constant readjustments, and occasional major operations. This is the way in which the race has grown to its present stature, and, since the race has not changed materially, I see no very great chance for changing radically the fundamental concepts on which its progress is made.

On the other hand, I invite you to study the ways of the automotive industry. Here is competition of the keenest. But its executives and managerial personnel do not believe that progress lies in the reduced content of the pay envelope and in longer hours of labor. They regard their job as the continuing development of better principles of management and of production, to the end that the pay envelope may bulge and that the number of available customers may be increased. Truly, I idealize them just a bit; they are human like the rest of us, and there is always the temptation to take the easy way out. But they have had vision, they have vision, and they exercise it.

In so far as I am concerned, I would rather trust the future well-being of myself and of mine to such individuals who are constantly striving for improvement than to the dead, or at best the paralytic, hand of government. I would rather live in the turmoil of competitive industry, which has shown by its results that it does tend toward improved status of the mass, than to accept the dead level of placidity that, in theory at least, results from governmental regimentation, be it under the name of the totalitarian state or in any other guise. I would rather give capital its small return while engaged in the task of making the wage earner also the capitalist than I would put capital goods, their ownership and their use, in the hands or under the complete control of even an ideally perfect government, to say nothing of real government as it has always been throughout the recorded history of the race.



Gerald Young

METHODS *of* CONTROL *in the* AUTOMOBILE INDUSTRY

By J. W. SCOVILLE

CHRYSLER CORPORATION, HIGHLAND PARK, MICH.

WE ARE meeting tonight in a great industrial city which is at the hub of the motor-car industry with spokes of the wheel reaching out to Flint, Pontiac, Lansing, Toledo, and other surrounding cities. Michigan alone produces about 63 per cent of the automotive output and Michigan, Ohio, and Indiana about 80 per cent. In the limited time at my disposal, I cannot give you a complete picture of the operations of a large automobile company, but we can take a little excursion behind the scenes, and discuss a few of the problems that confront the management, and see how the problems are handled.

As you know, the custom of the industry is to produce annual models. The first step in bringing out a new model is to fix the price at which the car is to be sold at retail. From this, are deducted the dealer's commission and an estimated sum to cover overhead expenses and profits. What remains is the cost of manufacturing the car, and this price is passed on to the estimating department with instructions to see how good a car can be built for this amount of money. Then the estimating, purchasing, and engineering departments go into a huddle. They estimate the cost of each part to be purchased and each part to be made in the factory. If the resulting total cost is too high, they try to keep the cost down by reengineering some part or by improving some manufacturing process.

A great silent battle goes on behind the scenes. The car must be as perfect as possible, and yet the manufacturing cost must be kept as low as possible so that the public can afford to buy the cars. Naturally, the cost per vehicle will depend on how many cars can be sold, and the management would like to know how many can be sold. But, to estimate the probable sales, we should know two things; how many cars the industry will sell, and what percentage of this business we can secure.

Fig. 1 shows the annual production of automobiles in the United States and Canada for 23 years. Note how much the production fluctuates from year to year. Output will frequently vary 25 per cent or more from the output of the preceding year. How many cars will the industry produce next year? Who can tell? Nor is it easy to determine what percentage of the business will be secured by a given make of car.

Fig. 2 shows for 9 years the percentage of passenger-car sales secured by two makes of car, which we will call *A* and *B*. Car *A* which secured only 2 per cent of the sales in 1930 advanced to nearly 5.5 per cent of the total in 1935, while car *B*, which secured over 6 per cent of the sales in 1928 dropped to less than 3 per cent in 1933. After the car is priced and engineered, tools and dies are bought for its production, an advertising campaign is started, and millions of dollars are spent before a single car is produced, and yet no one knows how many cars will be made in the next year or how the particular car will capture the public fancy. The automobile manufacturer bets millions of dollars on the competence of his engineering and manufacturing staff.

COMPETITION DETERMINES PRICES WHICH REMAIN STABLE

Certain economists criticize the pricing policies of the industry. They say that automobile prices are not competitive, that they are not determined by the forces of supply and demand. They say that some brass hat sits in a swivel chair and issues a ukase that the price of the XYZ car next year will be $795; take it or leave it. The price is likely to be stable for the entire year, it does not have the jitters and dance up and down like the price of wheat on the Board of Trade or the price of a stock on the New York Stock Exchange. They call these prices administered prices. There are, of course, other items in the bill of complaint. They say that automobile prices are too rigid, that they did not decline enough in the depression to keep up the sales volume. They say that, while the farmers kept on producing and suffered a ruinous price decline, the automobile makers preferred to slow down the production and keep up the price.

Fig. 3 throws some light on the question, "Is automobile manufacturing a competitive business?" The vertical columns represent the

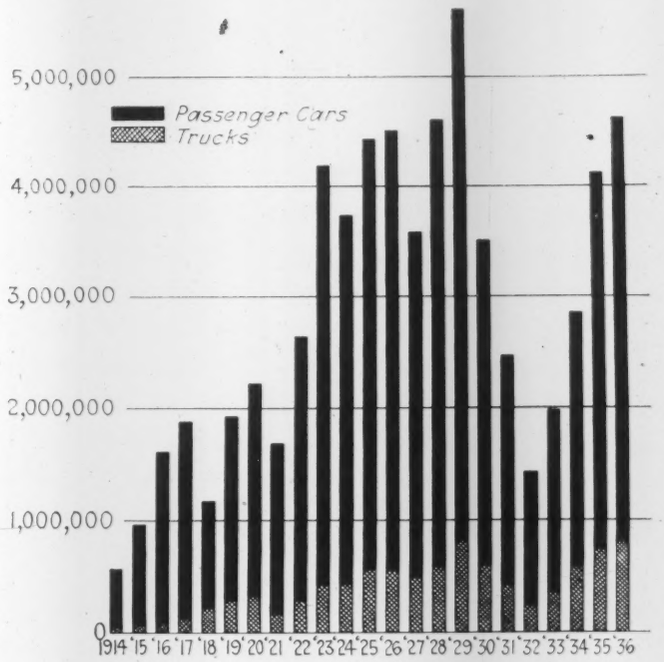


FIG. 1 ANNUAL PRODUCTION OF PASSENGER CARS AND MOTOR TRUCKS IN THE UNITED STATES AND CANADA, 1914–1936, INCLUSIVE

Contributed under the joint auspices of the A.S.M.E. Management Division and the Society of Automotive Engineers, Inc., and presented at the Semi-Annual Meeting, Detroit, Mich., May 17–21, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

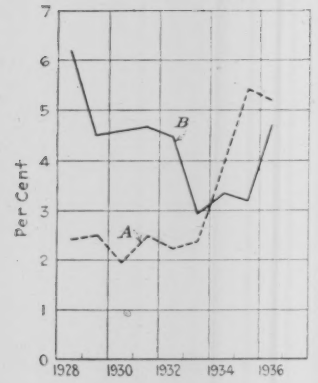


FIG. 2 PERCENTAGE OF PASSENGER-CAR SALES IN THE UNITED STATES SECURED BY TWO CARS BETWEEN 1928 AND 1936

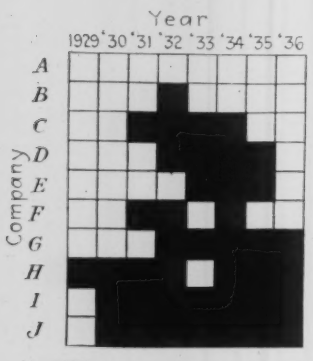


FIG. 3 YEARS FROM 1929 TO 1936, IN WHICH TEN AUTOMOBILE COMPANIES MADE A PROFIT

(Blocked squares represent the years in which the companies lost money.)

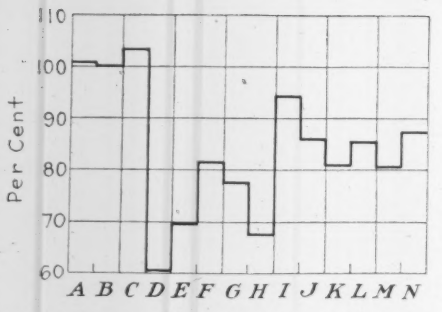


FIG. 4 WHOLESALE PRICES OF 14 MAKES OF PASSENGER CARS IN 1933

(Prices are plotted as percentages of the 1929 wholesale prices.)

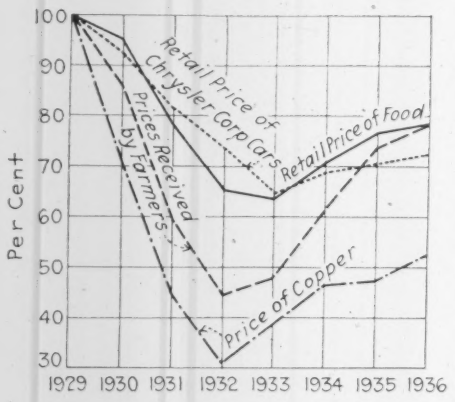


FIG. 5 RETAIL PRICE OF CHRYSLER CARS, 1929–1936, INCLUSIVE, COMPARED WITH RETAIL PRICES OF FOOD, ALL FARM PRODUCTS, AND COPPER

(Prices are annual averages in all cases and are plotted as percentages of the 1929 figures.)

years from 1929 to 1936, and ten manufacturers are indicated by the letters *A* to *J*. If a company lost money in a certain year, the square has been blocked in. Companies *H*, *I*, and *J* lost money in seven of the eight years; company *G* lost money in five years; and companies *C* and *D* lost money in four of the eight years. If it is true that automobile prices are set without regard to supply and demand, then it is peculiar that so many of the companies set their prices so low that they lost money. Less than 3 per cent of the companies that went into automobile manufacturing have survived. Over 1000 makes of passenger car have been offered to the American public. But in 1922, only 93 makes were on the market; in 1928, there were only 45; and now, the number has declined to only 24. We must admit that automobile manufacturing is highly competitive; no producer has the power which comes from monopolistic control.

I do not know much about economics, and I do not know anything about engineering, but, as a layman, it seems to me that somebody sets the price of everything I buy. Of course, I do not always buy. If I go to a farmer to buy a dozen eggs or a bushel of apples, he tells me in each case what the price is. Presumably, he is influenced by the prices asked by neighboring farmers, just as the automobile manufacturer is influenced by the prices put on competing cars. I wish some of these scholars would explain to me sometime just what they mean by administered prices. Also, I want to tell you of another criticism; they say we set the price so as to maximize profits. While the rest of the world, the doctors, lawyers, politicians, preachers, and reformers are unselfishly working for humanity, we are so benighted and so worldly that we try to look out for ourselves. Well, maybe we try, but the record shows that we are not very adept at maximizing. However, in the language of Mr. Ford, we have put the people on wheels.

In Fig. 4, the 1933 wholesale prices of 14 makes of passenger cars are plotted as a percentage of the 1929 prices. The makes are designated by the letters *A* to *N*. Cars *A*, *B*, and *C* did not decline in price, while car *D* showed a decline of 40 per cent, the average being between 15 and 20 per cent. As you know, the quality of cars has been greatly improved since 1929. Average car life has advanced from about seven to well over eight years. Perhaps, it is over nine. The thesis that automobile factories could have kept running full blast in the depression if prices had been reduced more is unproved. People do not like to buy on a falling market. After one drop in price, they are likely to wait for the next drop. Had the automobile companies reduced prices more in the depression, probably many more of them would have gone bankrupt, with the attendant social losses resulting from disintegration of factory personnel and dealer organization and with loss of the equities of investors.

The solid line at the top of Fig. 5 shows the average annual retail price of food in the United States from 1929 to 1936, with the 1929 price taken as 100 per cent. The dotted line shows the average retail price of all cars built by the Chrysler Corporation. Note that as the depression deepened, the retail price of Chrysler cars fell about as fast as the price of food. In the last three years, the price of our cars has advanced less than the price of food. The dash line shows the average annual prices received by farmers for all farm products, and the dot-dash line shows the price of copper, one of the materials entering into an automobile. The price behavior of copper was typical of many other raw materials used in an automobile. As we start with the raw materials from farms and mines and work them up into finished products, the cost element that is added is mainly labor. Wage rates are rather rigid and, since finished products are mainly crystallized wages, comparative rigidity in the prices of finished goods is due in large part to the comparative rigidity of hourly wage rates.

I believe, and here we get right down to engineering design, that some things in this world ought to be rigid. If I drive across a bridge, I want it to be rigid. But when I go to bed, I do not want to sleep on the slats. I want some flexible springs and cushions under me. Economic reformers will shed great salty tears over the flexibility of farm-products prices, and they cry more when they flex down than when they flex up. They get excited over the flexibility of stock-market prices. They get a rule passed that the price of corn cannot fluctuate more than 4 cents in a day. Then, they turn right around and excoriate the manufacturer because his prices are too rigid. They try to stabilize foreign exchange rates, they fix the price of gold at $35 an ounce, and announce that they aim to have the price level stable for a generation. In one breath, they claim that stability is a virtue and, in the next breath, that stability is a sin. I do not understand it. If price is to be the great regu-

lator of our economic life, price changes will, and should, be different for each commodity. Prices of automobiles should not depend on those of wheat or cotton or lard. Automobile prices are determined by what it costs to build them and what the public is willing to pay for them. Let every tub stand on its own bottom.

WAGE RATES INCREASE MORE RAPIDLY THAN CAR PRICES

Fig. 6 compares average hourly wage rates in our factories with the retail prices paid for our cars. In each case, the 1929 price is taken as 100 per cent. From 1929 to 1933, wage rates declined much less than car prices and, in the last 3 years, wage rates have advanced much more rapidly than car prices.

In corporate management, the emphasis changes from month to month and from year to year. At one time, the big problem is to develop sales; at another, the big task is to speed up production; right now, the big problem is to secure harmony and cooperation between employers and employees. I do not care to discuss the labor problem; working as I do with pencil and slide rule, instead of hammer and wrench, anything I said would be prejudiced, coercive, unfair, illegal, and perhaps, downright

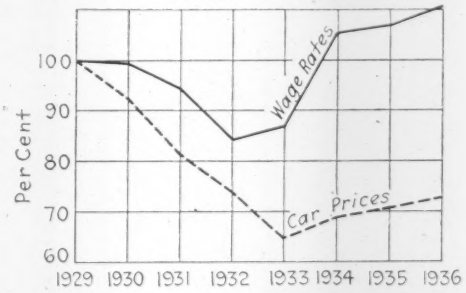


FIG. 6 RELATION BETWEEN AVERAGE HOURLY WAGE RATES PAID BY THE CHRYSLER CORPORATION AND RETAIL PRICES RECEIVED FOR THE CARS IT SOLD, 1929–1936, INCLUSIVE

(From 1929 to 1933, car prices declined more rapidly than wage rates, and, since 1933, wage rates have advanced much more than car prices.)

sinful. So, I will just stop at this point to show trends based on the U. S. census of manufactures for the automotive industry. The solid line at the top of Fig. 7 shows wages as a percentage of the value added by manufacture for the period 1921 to 1935. The broken line gives the value added by manufacture per employee working one year. The curve in the center shows wages as a percentage of the value of product, and that at the bottom shows the number of vehicles produced per man-year. In 1925 and in 1935, one worker produced about ten cars in a year. At the end of this ten-year period, the average worker put in less hours of work, and this reduction in working time was offset by the management through use of better machines, equipment, organization, and management.

The workmen probably average no higher in skill or industry than ten years ago, but they can produce more per hour of labor on account of better equipment and methods supplied by management. I do not like these terms, employees and management. We are all workers. The only difference is that we work at different tasks. If an engineer redesigns or invents a machine that will turn out more work per hour, then the man operating the machine may turn out more pieces per hour. We get greater productivity per hour of labor, caused by the thinking done by the engineer. Of course, the grimy-faced toiler in the shop may be a thinker too. The point I want to make is that the increased productivity of industry has been due to brains. Would not our thinking be clarified if we stopped using the phrase "productivity of labor" and instead used "productivity of industry." Industry is a broader term and includes inventors, technicians, and all workers, while labor is used in a more restricted sense to mean only machine operators and manual workers.

The management of an automobile company has a threefold responsibility to the consuming public, the workmen, and the

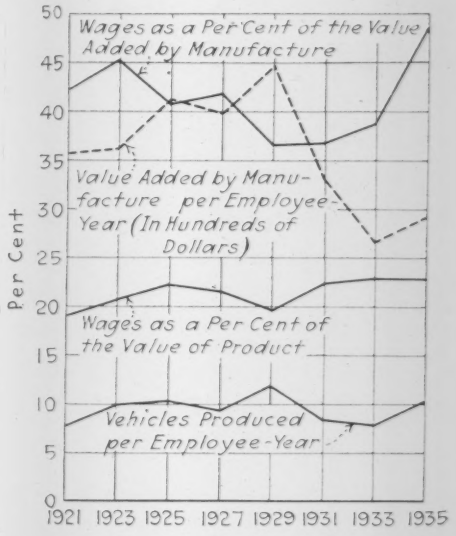


FIG. 7 CURVES SHOWING WAGES AS A PERCENTAGE OF THE VALUE ADDED BY MANUFACTURE AND THE VALUE OF THE PRODUCT AND THE VALUE ADDED BY MANUFACTURE AND THE NUMBER OF VEHICLES PRODUCED PER EMPLOYEE-YEAR

(These figures cover the period from 1921–1935, inclusive, and are based on the U. S. Census of Manufactures.)

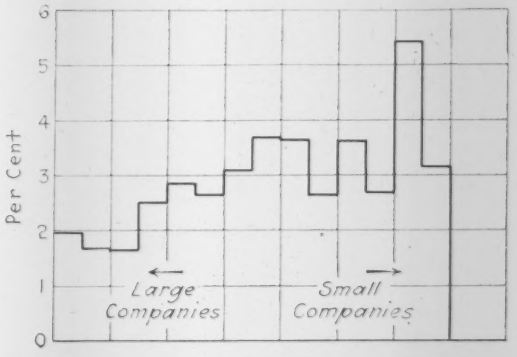


FIG. 8 PERCENTAGE OF SALES SPENT IN 1936 BY 14 PASSENGER-CAR COMPANIES FOR ADVERTISING

(Cars are arranged from left to right. Note that the companies with the largest sales spent the smallest percentage of sales for advertising.)

owners of the property. The automotive industry has met the challenge and has operated in a manner to benefit society. To the public, it has given improved cars at lower cost; to the workmen, it has paid high wages, about the highest paid by any industry; and, to the investor in the successful companies, it has paid good dividends.

SEVEN LARGEST COMPANIES SOLD 95 PER CENT OF THE CARS

From a purely selfish standpoint, the automobile manufacturer seeks a low price to get a big volume. In ancient times, huge dinosaurs roamed over the land, but they have passed away; perhaps they were too big to live. However, in the automotive industry, it is the dinosaurs that survive. As out-

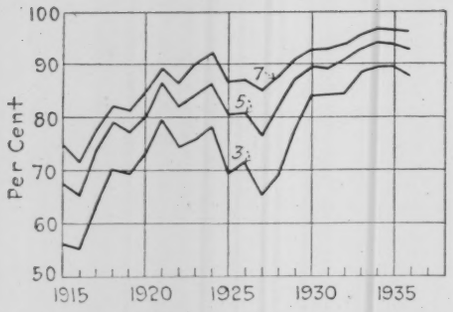


FIG. 9 PERCENTAGE OF AUTOMOBILES PRODUCED EACH YEAR, 1915–1936, INCLUSIVE, BY THE LEADING THREE, FIVE, AND SEVEN COMPANIES IN THE UNITED STATES AND CANADA

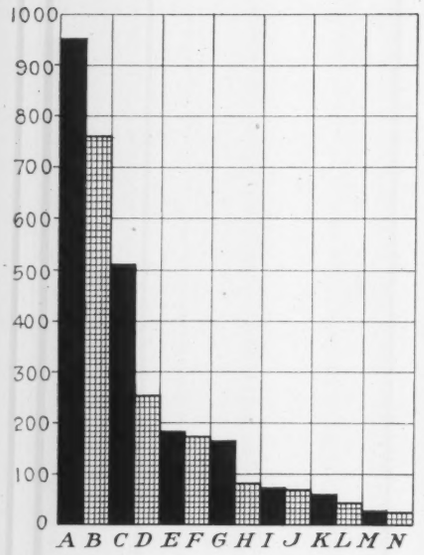


FIG. 10 (RIGHT) SALES IN 1936 OF THE 14 MOST POPULAR PASSENGER CARS

(Three companies secured 64 per cent of the sales and seven companies, 86.5 per cent. The largest manufacturer built only 43 per cent of all cars sold.)

put increases, the cost per vehicle for tools and dies, advertising and other overhead expenses declines. Fig. 8 shows the 1936 advertising expenditures for 14 makes of car, as a percentage of sales. Cars are arranged in order of sales, the largest sellers at the left, the smallest at the right, and the percentage spent for advertising tends to rise as the volume of sales declines. Advertising is, of course, only one overhead expense. The same principle applies to each item of overhead expense. Specialized machines can be installed, which are economical for the large producer but would be too costly for the small producer. In Fig. 9, we see how automobile building has gravitated to the large producers. In the last 20 years, the proportion of business secured by the three largest companies has advanced from 55 to nearly 90 per cent of the total. The proportion of the business secured by the seven largest companies has advanced from about 72 to about 95 per cent. The progress of the automotive industry illustrates the biblical saying, "To him that hath shall be given." Not only is the business concentrated in a few companies, it is also concentrated in a few makes.

Fig. 10 shows the 1936 sales of the 14 most popular makes of passenger cars. Three makes took 64 per cent of the business and seven makes took 86½ per cent. This concentration is socially desirable. The public secures the low prices that come from large-scale operations without the dangers inherent in monopoly. For there is no monopoly. The largest manufacturer builds only 43 per cent of the cars; the next largest, 25 per cent.

Behind the scenes, a savage battle for volume is always in progress, for the life expectancy of a manufacturing corporation increases with the volume of sales. In fighting this battle, the manufacturer has three big pieces of artillery (*a*) car, (*b*) price, and (*c*) dealer and service organization. In selling cement, or coal, or copper, price is all important. However, in selling automobiles, price is only one of the elements that determine volume. For the automobile is a prized personal possession. It has an individuality, a personality. Some of our engineers even go so far as to say that it has sex appeal. Consequently, in the depression the manufacturers lowered the price and improved the car. They used all the weapons available. Raw-material producers had only the price weapon; for iron is iron and wheat is wheat.

Perhaps a big market exists for a small car, stripped of all refinements and selling for a low price. Such cars are popular in Europe, where individual incomes are lower than here and gasoline prices and taxes are higher. In this country, such a car might not be popular. It would be in competition with the 6,000,000 used cars that change hands in the year. The American people want a big-quality car as well as a reasonably low price.

Comparative stability of automobile prices in the model year is highly desirable; it tends to prevent speculative buying by dealers and by the public and, thus, enables the factories to plan and operate on reasonably uniform monthly schedules. Fig. 11 gives a comparison of automobile prices with prices of all commodities and farm products, prices from 1909 to 1914 being taken as 100 per cent. The trend of automobile prices has been downward with a constantly improved product. Pricing policies of the industry have resulted in better values to the public and in the almost complete motorization of this nation, and all this has happened in my lifetime. Critics of industry should judge it by the results. As the Bible says, "Wherefore, by their fruits ye shall know them."

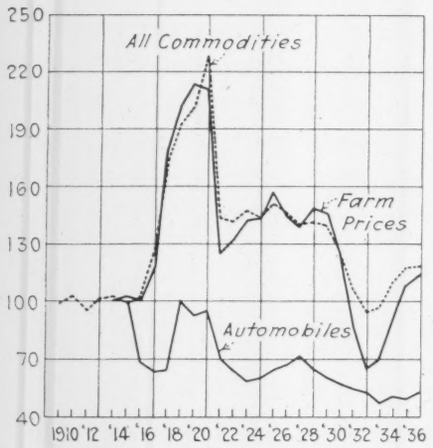


FIG. 11 COMPARISON OF AUTOMOBILE, ALL-COMMODITIES, AND FARM-PRODUCTS PRICES FROM 1909 TO 1936, INCLUSIVE

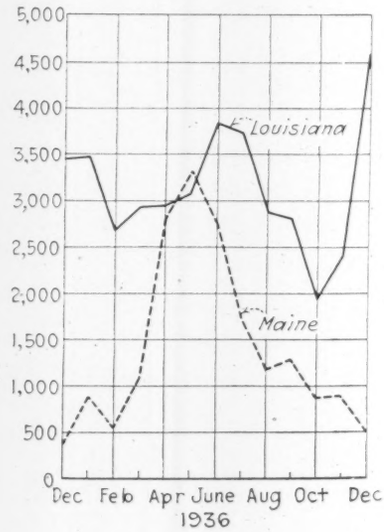
(Prices from 1909 to 1914 are taken as the base for plotting in all cases.)

FIG. 12 (RIGHT) MONTHLY REGISTRATIONS OF NEW CARS IN MAINE AND LOUISIANA FOR 1936

(Severe winters restrict sales in Maine, the greater part being made in April, May, and June. Weather has no noticeable influence on sales in Louisiana.)

SEASONS AND NEW MODELS AFFECT CONSUMER DEMAND

Stabilizing weekly production at the factory in spite of fluctuations in consumer demand is another great problem for the automotive manufacturer. The seasons and new models are two main causes of fluctuating



consumer demand. Fig. 12 shows the monthly registrations in 1936 of new cars in Maine and Louisiana. In the northern states, the severe winters restrict car sales; a large part of the Maine sales are made in April, May, and June. In the southern states, the influence of the weather in causing a fluctuating demand is negligible.

If the weather were always balmy and we had no winter, demand in the first month that a new car is put on the market would rise to about 144 per cent of normal. This heavy demand comes mainly from city dwellers, who are more susceptible to changing styles than country folk. Demand then declines and, in six months, is down to about 80 per cent of normal, at which level it remains for about six months. In the six months preceding the new model, many buyers are waiting for the next new model. The change of models at first stimulates sales, but acts later as a depressant. Changes in demand that are caused by the introduction of new models are illustrated in Fig. 13 which also shows how consumer demand would be affected by the weather, assuming now that no new models are brought out. This chart is based on the fluctuations in used-car sales, where new models do not exist. The seasons reduce demand to about 70 per cent of the monthly average in December and raise it to about 130 per cent in May. A few years ago, the industry attempted to even out the demand by introducing new models about Nov. 1. The theory back of this move will be apparent from an examination of the two curves. In May and June, the seasonal demand is high but the new-model demand is low. In November, December, and January, the seasonal demand is low, but the new-model demand is high. Combination of these forces should produce relatively stable sales, but there are several flies in the ointment. In the month preceding the model change, dealers may be sold out and factories shut down for changes. Actual sales may then be far below demand. When new models are produced, capacity of the factories to turn out the cars may be much less than the public demand. Unusual factors, such as zero weather in February, 1936, the soldiers' bonus in June, 1936, strikes in automobile factories early in 1937, and the stock-market crash in October, 1929, put unexpected and unpredictable kinks in our sales forecasts.

Fig. 14 shows average changes in retail sales, production, and dealer stocks of passenger cars for 1935 and 1936. Dealer stocks advance from about 6 per cent of annual sales at the end of September to about 14 per cent at the end of March. In this period, production exceeds the retail sales. Production falls below retail sales in the next six months, so that the stocks of cars in dealers' hands may be liquidated. In August and September, production is curtailed drastically because of declining demand and the necessity of clearing the dealers' stocks. The following month, production is low because of difficulties in getting started on the new models. How much easier it is to stabilize output on paper than to do it in practice! How sad are the facts of life compared with our Utopian dreams! After all efforts to stabilize production, it still fluctuates as much as the retail sales. There appears to be no way of obviating a severe drop in production at the time of model change. However, the fluctuations in the labor force are much less than the fluctuations in output. In Fig. 15, the solid line shows, for 1935 and 1936, the monthly fluctuations in the number of automobile workers on the payroll, and the dash line shows the fluctuations in production. However, the number of people employed is not a true measure of work done; for in some weeks, many employees may be working overtime, and, in other weeks, the factory may be operating only two or three days a week. I have, therefore, introduced the dotted curve showing fluctuations in the number of hours worked. You will see that the labor force is stable compared with output. The reasons for this are:

(1) Production refers to final assembly of cars. But parts are being made in the weeks preceding the final assembly. When the assembly line is down for a model change, manufacture of engines and parts may be going at a brisk rate.

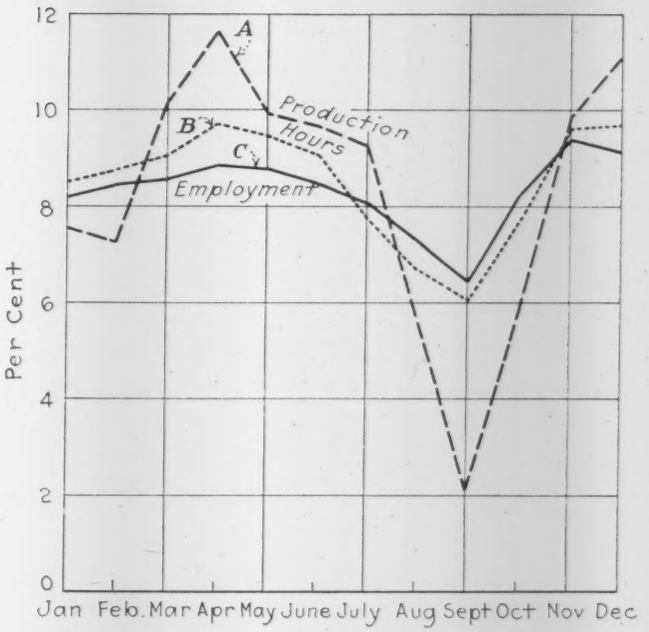


FIG. 15 MONTHLY FLUCTUATIONS IN 1935 AND 1936 IN NUMBER OF WORKERS, PRODUCTION, AND NUMBER OF HOURS WORKED

(The production curve is for passenger cars only, the man-hour curve is for both automobile and body plants, and the employment curve also includes parts manufacturers. While these curves are not strictly comparable, because of the different plants included, the labor force is stable compared with production.)

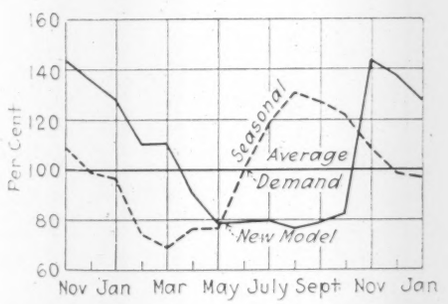


FIG. 13 VARIATION IN NEW MODEL AND SEASONAL DEMANDS

(Introduction of new models about Nov. 1 is the industry's answer to these conditions.)

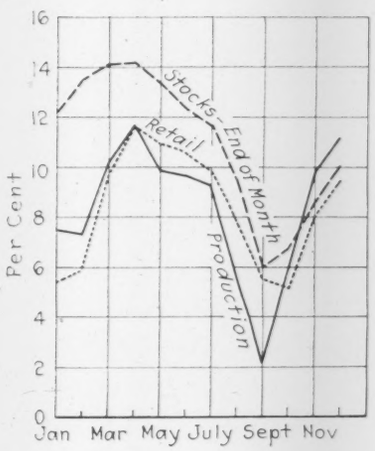


FIG. 14 (RIGHT) AVERAGE CHANGES IN RETAIL SALES, DEALER STOCKS, AND PRODUCTION FOR 1935 AND 1936 EXPRESSED AS PERCENTAGES OF ANNUAL SALES

(2) In the winter, surplus banks of parts are made and stored for cars that will be assembled in the spring.

(3) Employment of certain workers does not depend on rate of production.

With November 1 as the date for introduction of new models, the low month of employment is September, when the workmen can enjoy a trip or a vacation. In my opinion, the seasonal nature of automotive employment has been greatly overexploited. Automotive employment is not very seasonal and never has been in times of business stability. In the depression years, employment fluctuated more because executives could not foresee that the depression would continually get worse, and, hence, too high a proportion of the yearly output would be made in the first half of the year. Suppose that a manufacturer expected to build 100,000 cars in 1932. He might have produced 50,000 in the first half of the year and then found that the demand had

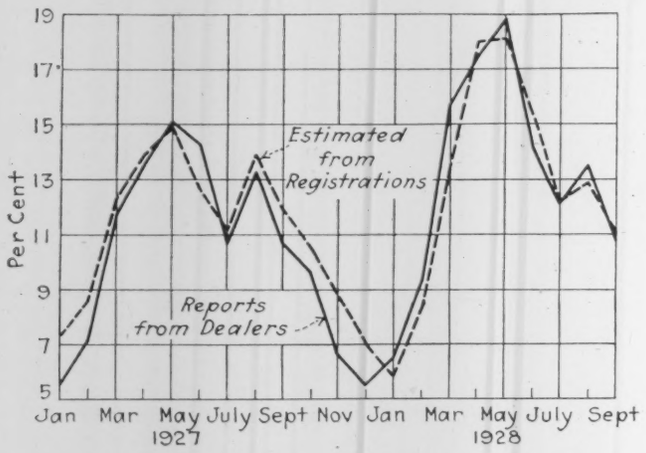


FIG. 16 PASSENGER-CAR SALES, AS ESTIMATED FROM NEW-CAR REGISTRATIONS, AGREE CLOSELY WITH ACTUAL DELIVERIES

declined so much that he could sell only 80,000. This decline in the actual sales below the estimate would perhaps all fall in the last half of the year.

EFFORTS TO STABILIZE OUTPUT

Automobile builders cannot write a schedule for 12 months in advance but must be constantly alert to changing rate of sales and inventory of unsold cars in the field. This is accomplished by a system of dealer reports, which are made three or four times a month by each Chrysler dealer and give his new and used car sales during the week and the number of unsold cars on hand at the end of the week. Each report is mailed to arrive at the regional office by Monday noon. These reports are summarized in each regional office and the results telegraphed to Detroit. On Tuesday forenoon, our executives know how many new and used cars were sold to the public in the preceding week and the number of unsold cars in stock. Knowing the current rate of sales and the normal seasonal movement, future sales until the model change can be forecast. Deducting from this figure the predetermined liquidation of field stocks, we have an estimate of the remaining production of the current model. This forecast becomes extremely important late in June, when final orders are given to vendors on the total number of parts required. If too many cars are made, the dealers close the model year with stocks of old model cars which must be sold at a loss; if too few cars are made, the dealers run out of cars and lose business. This final forecast of the year's output is tremendously important.

In addition to the dealer reports, new-car registration figures are purchased, which show the number of cars of each make sold each month in each county. For many years, I have estimated, from registration figures, the monthly deliveries of each make of car. In 1928, when Dodge Brothers was merged with the Chrysler Corporation, I obtained access to the confidential Dodge delivery figures based on dealer reports. Fig. 16 compares my estimates with the Dodge confidential figures, and the close agreement of these figures gave me quite a thrill, for then I knew that my estimates on competitors' sales were just about right. I suppose that few, if any, industries compare with the automotive in exact and timely information on consumer de-

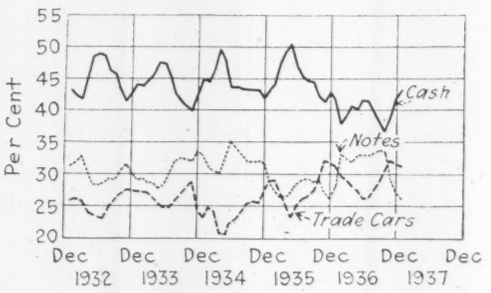


FIG. 17 PERCENTAGES OF DEALER INCOME FROM THE SALE OF NEW PLYMOUTHS THAT WERE REPRESENTED BY CASH, NOTES, AND TRADE-IN ALLOWANCES, 1932–1937

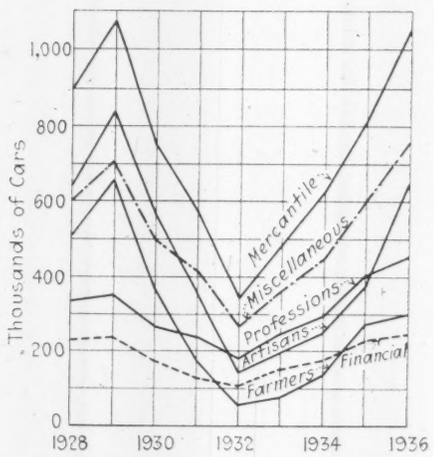


FIG. 18 ESTIMATED ANNUAL SALES OF PASSENGER CARS BETWEEN 1928 AND 1936, INCLUSIVE, ARRANGED BY OCCUPATIONAL GROUPS
(Sales to artisans rose rapidly in 1936 and were almost as high as 1929, while sales to farmers increased only slightly in 1936 and were far below predepression levels.)

mand. In some companies, a report is secured from dealers on each car sold at retail. Reports secured from Chrysler Corporation dealers shows the buyer's name, address, and occupation; dealer, salesman, and delivery date; amount of cash paid, kind of trade car turned in and the amount allowed for it, notes given and the finance company, serial number and body type of the car sold, and other pertinent facts. If any of you engineers bought one of our cars last year, and I suppose many of you did, for we sold 13,291 vehicles last year to engineers, we have a complete record of the transaction in our files. This information is punched on a Hollerith card and at the end of the month, these cards are run through sorters and tabulators and reports are issued giving an accurate picture of the retail situation.

Fig. 17 is based on these Hollerith card analyses and shows by months, from 1932 to 1937, the percentages of dealer income

from Plymouth sales represented by cash, notes, and allowance for cars taken in trade. The cash percentage rises in summer and the percentage allowed for trade cars falls correspondingly. An estimate, based on these card records, of the number of new cars bought each year, 1928–1936, inclusive, by various occupational groups is presented in Fig. 18. Sales to artisans (factory workers, mechanics, painters, plumbers, and similar occupations) rose rapidly last year and approached predepression levels, while sales to farmers rose but little last year and are far below predepression levels. Our records show that city workers prospered more last year than any other group. The biggest market for new cars is the mercantile group, consisting of salesmen, merchants, grocers, jewelers, and the like. Time is too short to cover this phase completely, but I want you to know that the automotive executive is equipped with a vast assortment of statistical facts. He "knows all, sees all" or closely approaches this state of omniscience.

CONTROLLING THE ASSEMBLY LINES

From the problem of scheduling by months let us pass on to that of scheduling by days. Standing by the assembly line is always fascinating. At one end a frame is placed on the conveyor, and then, axles, wheels, and fenders seem to come on the conveyors from nowhere to join the frame. Then, a blue sedan body swings down from an overhead track to match the blue fenders. And finally, after only 60 min, the car moves off under its own power. That is a great moment—like the launching of a ship or the birth of a child—when those parts, which an hour before were scattered about in bins and piles and freight cars, join hands to make a beautiful piece of mechanical harmony, a bright shining car that is almost a thing of life.

You might think we could make up a batch of automobiles of various colors and body types, store them near the factory and make shipments to dealers from this stock. However, objections to this plan exist. The automobile is a bulky object, and the output of even one day would cover acres of ground. It is a costly article and is easily scratched and injured. Then, again, automobiles differ in color, upholstery, body type, tires, and accessories. For example, we could build a Plymouth car for every family in the United States and have no two alike. By using every conceivable combination, we could produce over 54 million cars, and no two would be alike. Several years ago, we had a yard full of Plymouths and a book full of orders, and yet we could not ship. No one could find the cars to make up an order. Now, we have a system. No car is shipped without an order from a dealer. These orders are sorted and handed each day to the planning department for the production that is to take place a week later. A list of the cars to be built a week from now was sent today to the body plants so they can frame up the bodies according to the body types and colors required. Then a week later, these bodies are trucked in from the body plants.

In the control room, one man sits at a board with several hundred vertical nails in it—each nail representing a certain kind of body, according to body type, color, and upholstery. When a load of bodies arrives, he receives a list of them and starts putting little washers on the nails. For instance, if one nail has, say seven washers on it, it may mean that seven blue sedan bodies with cloth upholstery are in the plant. Then, a man takes the order sheet and lists on the track sheet the cars that are to be produced according to the order in which they are to come off the final assembly. Every time he writes down the specifications of the next car to be built, off comes a washer. Thus, the washers give a minute-to-minute inventory of available bodies in the plant. This track sheet is made in 12 copies. One copy goes to the man who puts the bodies on the feeder line, another copy to the man who puts the fenders on the conveyor, another copy to the man who puts the frame on the line, and so on. When a blue body is put on the feeder line, some one else is putting on the blue fenders, and some one else the proper wheels and tires, so that when these various parts finally meet on the assembly line, it will be the car the dealer specified in his order. All feeder lines work from the same track sheets, but because the latest bulletin from the control room may not arrive quickly enough at a point half a mile away, another man in the control room puts the specifications on a telautograph so the faraway feeder line has instant information on the last cars that have been boarded in the control room. This plan is simple, but it brings about a coordination in the factory which is marvellous. When the car comes off the final assembly line, it carries a sticker that gives the dealer's order number. Over on the storage lot, each order number is assigned to a bay that holds four cars. The car is then whisked away to its allotted space on the lot, and, when all the cars that are specified on the order have arrived on the storage lot, they are turned over to the traffic department to be loaded and shipped.

Many other things could be talked about; problems of control that center around merchandising of the cars, financial operations, problems of personnel, and what we call industrial relations. Without extending the discussion, I have tried to show that in corporation management, the automobile industry must, and to a large degree does, follow the methods of the engineer. There must be exact quantitative thinking based on factual information. In engineering, you deal largely with metals and minerals. However, in corporation control, the materials are to a large degree human beings, and predicting what a bar of iron will do under given conditions is easier than predicting what a man will do. In the larger problems of corporation management, we can imitate the methods of the engineer, but we cannot equal the engineer in exactness and precision.

Courtesy of the Midvale Co

RESEARCH *on* FLOW NOZZLES

Record of Progress in the Work of the A.S.M.E. Special Research Committee on Fluid Meters

By HOWARD S. BEAN

GAS-MEASURING INSTRUMENTS SECTION, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

FOR OVER 25 years, flow nozzles have been used to measure fluid flow. In many cases, these measurements have been a part of some test, such as the test of a blower or a turbine. At other times, nozzles have been used as primary or reference meters with which to test other flow-measuring devices. In all such instances, it was necessary to calibrate the nozzles used. Results of some calibrations have been published either in conjunction with the report of the principal project or as a separate paper; for example, "The Impact Tube," by Dr. S. A. Moss;[1] "Discharge Coefficients of Orifices," by H. S. Bean, E. Buckingham, and P. S. Murphy;[2] and "Fluid-Meter Nozzles," by B. O. Buckland.[3] While the information given in these papers was of high quality, the range of conditions covered by the tests was limited, so that the conclusions which could be drawn from them, taken together, left much to be desired. Moreover, the designs of nozzles used in these tests were not all alike, except in one respect, namely, the total lengths, as measured along their axes, was from about one and a quarter to two throat diameters.

EARLY FORMS OF FLOW NOZZLE

By about 1930, the A.S.M.E. Power Test Codes Committee had tentatively proposed the use of a nozzle form that had an inlet curve approximating an elliptical quadrant and a total length of about $1^3/_4$ times the throat diameter. About the same time, the Compressed Air Society was proposing a somewhat similar nozzle, the main difference being that the entrance curve of this nozzle was more nearly, if not exactly, a circular quadrant.

Concurrently with these developments, a preliminary draft of recommendations for the measurement of fluids was prepared by Committee No. 30 on the Measurement of Fluids, of the International Standards Association.[4] A copy of this draft was sent to the American Standards Association, by which it was in turn referred to the A.S.M.E. Since it was expected that this draft would ultimately be the basis for a code on fluid measurements, the matter was naturally submitted to a Power Test Codes Committee for consideration.

Several Power Test Codes Committees had to make fluid measurements as part of the complete test of the particular power unit with which they were dealing, and, naturally, each such committee looked at the problem from its own particular point of view. As this situation developed, it became increasingly evident that a committee should be formed to deal with the subject of fluid measurements. The necessity for submitting the I.S.A. draft to such a committee for study and report served as the immediate incentive for its formation. It was designated as the Subcommittee on Measurement of Fluid Flow of the A.S.M.E. Power Test Codes Committee No. 19 on Instruments and Apparatus and has the following personnel: W. A. Carter, chairman, H. S. Bean, W. W. Johnson, S. A. Moss, R. J. S. Pigott, and R. B. Smith.

This committee held its first meeting in January, 1934. Two days were spent in reviewing the general status of information on fluid measurements and the I.S.A. draft. It was this committee that suggested the name of "long-radius" nozzles as a generic term for the particular designs of nozzles most used in this country. This name seemed appropriate, since it would call attention to the difference between these nozzles and the much shorter I.S.A. nozzles. The conclusions and recommendations which were reported from this meeting may be summarized as follows:

(1) The I.S.A. nozzle may be used as provided in the draft of the report of I.S.A. Committee No. 30, including coefficients, correction factors, and tolerances.

(2) Owing to the fact that existing data on long-radius nozzles are limited and scattered, measurements made with them are to be considered as subject to a tolerance of ±1.5 per cent, unless the nozzle is calibrated.

(3) The Power Test Codes Committee should request the A.S.M.E. Special Research Committee on Fluid Meters to make a thorough research on flow nozzles, paying particular attention to long-radius nozzles, but including some I.S.A. nozzles and venturi nozzles and tubes.

It may be of interest to give some of the reasons on which the committee's action was based. It found that the proposed I.S.A. report was based on extensive test data of high quality, so that, for flow nozzles, it was the most complete report available. Data that had been obtained in this country on long-radius nozzles could not be overlooked, however, and the committee felt obliged to take cognizance of the number of such nozzles being used and of the fact that they would continue to be used regardless of what action it might take. Moreover, the committee was not convinced that the I.S.A. nozzle was superior to some designs of long-radius nozzle or would produce any more satisfactory coefficient relations; indeed, it was felt that there were valid objections to the corner pressure connections that were recommended for use with the I.S.A. nozzle.

FLOW-NOZZLE RESEARCH PROGRAM INAUGURATED

As provided by the third of the foregoing conclusions, the Power Test Codes Committee requested the Special Research Committee on Fluid Meters to carry out a research on flow

[1] "The Impact Tube," by S. A. Moss, Trans. A.S.M.E., vol. 38, 1916, pp. 761–797.

[2] "Discharge Coefficients of Square-Edged Orifices for Measuring the Flow of Air," by H. S. Bean, E. Buckingham, and P. S. Murphy, *Bureau of Standards Journal of Research*, vol. 2, 1929, pp. 561–658.

[3] "Fluid-Meter Nozzles," by B. O. Buckland, Trans. A.S.M.E., vol. 56, 1934, pp. 827–832, paper FSP-56-14, and (discussion), vol. 57, 1935, pp. 251–256.

[4] "Rules for Measuring the Flow of Fluids by Means of Nozzles and Orifice Plates," Preliminary Recommendations, I.S.A. Bulletin No. 9, 1935.

Contributed by the A.S.M.E. Special Research Committee on Fluid Meters. Approved for Publication by the Director of the National Bureau of Standards.

nozzles. While some members of the latter committee gave some thought to this request in the meantime, it was not until the committee met in December, 1934, that any formal action was taken. After some discussion, the committee decided to undertake such a research program, under the following general conditions:

(1) The research should be thorough and should cover a wide enough range of conditions so that the information gained would be of real value for some years to come.

(2) Planning and coordination of the tests, regardless of where they might be made, and correlation of results should be under the immediate direction of one person, with the possible assistance of a small subcommittee.

In accordance with the second condition, the author was requested to take charge of the research program. At a later date, S. R. Beitler, J. R. Carlton, R. E. Sprenkle, C. E. M. Stahl, and R. J. S. Pigott, ex-officio, were appointed to assist him as a subcommittee. Another subcommittee was appointed to secure the funds with which to carry on the program. Its personnel is C. E. M. Stahl, chairman, R. K. Blanchard, W. A. Carter, Paul Diserens, and L. K. Spink.

Some difference of opinion existed at first as to whether the committee should start by making tests on a variety of long-radius nozzle designs and, from the results of these tests, select a "standard committee" design; or select a "standard" design on the basis of the information then available and proceed immediately to make tests that could be used in industrial work. The former would be the more scientific approach but would delay starting any tests on an extensive scale. Moreover, the difference in the proposed designs of long-radius nozzles was not so great as to suggest that very much difference would be found in the results that would be obtained. It appeared that it would be possible to obtain sufficient information on the small effects of slight variations in design during the course of the work on the main object of the program. Also, it was certain that the supporters of the program would want usable results as soon as such data could be obtained. For these reasons, the second of the alternatives mentioned was decided upon.

SELECTING DESIGN FOR RESEARCH-PROGRAM NOZZLES DIFFICULT

Selecting a basis for designing the research-program nozzles proved to be more difficult than had been anticipated. Suggestions were almost as many as committee members, and there was strong insistence from some quarters that one or another of the designs that were being used commercially to some extent should be adopted. Others urged designs that had been used little, if at all. After more than nine months of discussion, the subcommittee finally adopted the following dual basis for designing its research-program nozzles:

(1) For all nozzles, the curved portion joining the flange with the throat shall be generated by revolving a quadrant of an ellipse.

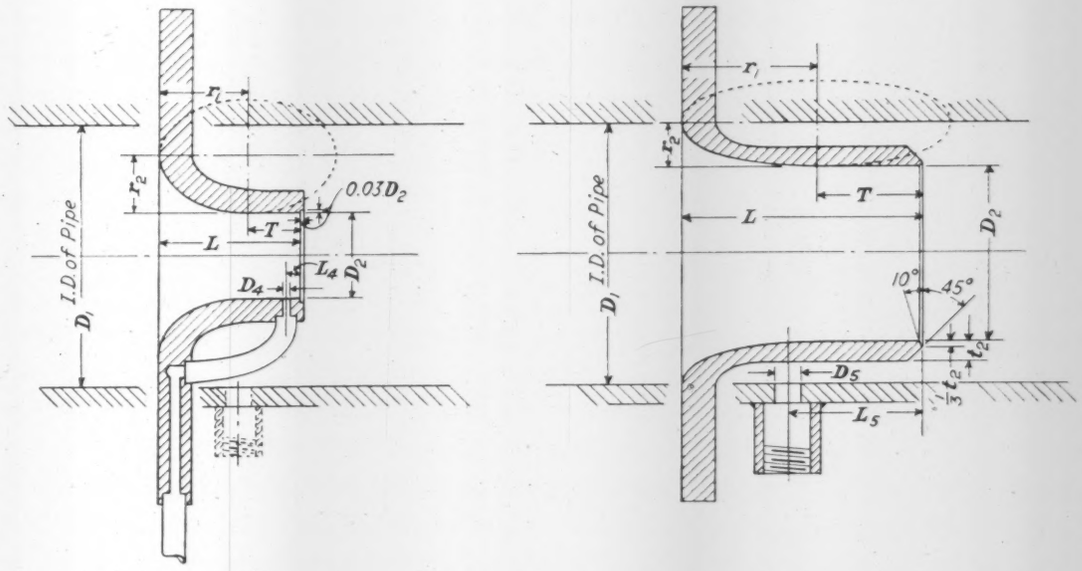
(2) When the diameter ratio β is less than 0.50, the semimajor axis of the generating ellipse shall equal D_2, and the semiminor axis shall equal $^2/_3\ D_2$.

(3) When the diameter ratio β is greater than 0.40, the semimajor axis of the ellipse shall equal $^1/_2\ D_1$, and the semiminor axis shall equal $^1/_2\ (D_1 - D_2)$.

(4) The length of the cylindrical throat section shall be $0.60\ D_2$ in all cases.

These relations are shown in Fig. 1. Other minor details arbitrarily agreed upon were: On the low-ratio series, the inner corner of the outlet end is to be counter-bored $0.03\ D_2$ each way, while, on the high-ratio series, the outlet end is to be beveled at 10 and 45 deg, on the inner and outer corners, respectively. Also, all low-ratio nozzles are to be fitted with a pressure tap in the nozzle throat and a tube leading out through the nozzle flange.

Some of the reasons for the dual relation, as given by (2)



Low β series, — $\beta < 0.5$

$r_1 = D_2$ $\quad D_4 = 0.079\sqrt{D_2}$
$r_2 = {}^2/_3\ D_2$ $\quad L_4 = 0.15\ D_2$
$T = 0.6\ D_2$

High β series, — $\beta > 0.4$

$r_1 = {}^1/_2\ D_1$ $\quad D_5 = 0.177\sqrt{D_1}$, $^1/_2$ in. max
$r_2 = {}^1/_2\ (D_1 - D_2)$ $\quad L_5 = 1{}^1/_2$ in. or over if possible (tentative)
$T = 0.6\ D_2$

FIG. 1 DESIGN RELATIONS OF LONG-RADIUS NOZZLES FOR A.S.M.E. FLOW-NOZZLE RESEARCH

(Either nozzle-throat or pipe-wall tap may be used. Latter should be back of nozzle outlet.)

and (3) are: The inlet surface of the lower-ratio series ceases to meet the pipe wall at 90 deg above $\beta = 0.43$. The subcommittee believed that more nearly geometrically similar flow patterns would be obtained if the inlet section contour were made to intersect the pipe wall at about the same angle for all diameter ratios. This is achieved over the entire range by the two relations. Also, using the relation given by (2) over the entire range would produce an undesirably long nozzle for the larger ratio sizes, while using relation (3) below a diameter ratio of 0.4 or 0.5 produces a nozzle with too much entrance surface. A third reason was that relation (2) has been used to some extent in making nozzles for use in acceptance tests. For this reason, the lower-ratio nozzles are sometimes referred to as "test nozzles." On the other hand, the relation given by (3) is substantially the same as one that has been used in some commercial measurements of fluids.

The overlap of the two relations between $\beta = 0.4$ and 0.5 was provided to eliminate a sharp breaking point between them. As the contours over this region produced by the two relations are so nearly identical, it is not expected that there will be any noticeable difference in nozzle coefficients.

FACILITIES AVAILABLE FOR TESTING NOZZLES AND PROGRESS MADE

While the nozzle form was being discussed, information was being gathered on facilities available for making tests in various laboratories and shops. It was realized from the start that no one laboratory had facilities for making tests covering the entire range of conditions which should be included in the program. On the other hand, it was not desirable to spread the work among too many places, because this would so reduce the support that the committee could hope to extend to each that the number of data obtained at each would be lessened, and their value would thus be reduced. From the information collected, it was decided to have the bulk of the tests divided among eight laboratories. These laboratories and the character of tests it is planned to have each of them make are shown in Table 1. In addition, a few additional tests may be made in the shops of other companies, such as the General Electric Company, Lynn, Mass., the Bailey Meter Company, Cleveland, Ohio; and the Ingersoll-Rand Company, Phillipsburg, N. J.

TABLE 1 LABORATORIES MAKING TESTS FOR THE FLOW-NOZZLE RESEARCH PROGRAM OF THE FLUID-METERS COMMITTEE

Laboratory	Pipe sizes, in.	Fluid
National Bureau of Standards, Washington, D. C.	2, 3, 4, 6, 8	Water and air
University of California,[a] Berkeley, Calif.	3, 4, 6, 8, 10	Water into air
Cornell University,[a] Ithaca, N. Y.	2, 3, 4, 8, 16, 24	Water
Lehigh University,[a] Bethlehem, Pa.	8, 10, 16, 24	Air
Massachusetts Institute of Technology,[a] Cambridge, Mass.	2	Steam
University of Oklahoma,[a] Norman, Okla.	2, 3, 4,	Oil
Ohio State University,[a] Columbus, Ohio	2, 3, 4, 6, 8, 10	Water and steam
University of Pennsylvania,[b] Philadelphia, Pa.	4, 6, 8, 10, 16	Water

[a] Department of mechanical engineering.
[b] School of civil engineering.

At present, the committee has had about 35 nozzles constructed, ranging in size from a $^1/_2$-in. nozzle for 2-in. pipe up to a 13-in. nozzle for 16-in. pipe. Some six or eight more are in course of construction, and about 12 additional nozzles, some of which are of the I.S.A. type, have been lent to the committee by different companies.

Tests are now in progress in five of the laboratories listed. At the University of Oklahoma, tests have been completed on about two-thirds of all the nozzles which are to be sent there. Tests at University of California, Ohio State University, and Massachusetts Institute of Technology are well under way. It appears probable, however, that the testing work will not be completed before the end of 1938, at the earliest.

In the last year, the subcommittee on funds has been active, and over $12,000 has been secured. It was estimated at first that about $15,000 might be sufficient for the entire program. This estimate, however, was based on the hope that most of the laboratories would bear a considerable portion of the expense by virtue of experimental engineering station funds. Unfortunately, it is now found that this will not be the case, and the committee is, therefore, faced with the alternatives of curtailing the program or securing more funds.

Galloway, N. Y.

MULTIPLYING OUR PRODUCTIVITY

By W. T. CHEVALIER

VICE-PRESIDENT, MCGRAW-HILL PUBLISHING COMPANY, NEW YORK, N. Y.

I do want to emphasize that the only thing that is wrong with our modern doctrine of multiplying productivity through the application of power and machinery is the fact that we have not yet learned how to devise a system of tokens and checks which will effect the exchange of the great wealth that we produce on an equitable basis without becoming the tool of manipulative speculation, whereby we try to acquire without the labor of creating. To say that is easy enough, but it is not easy to remedy. After all, if it is that easy to say and to see, why should we be staggered by the job of approaching a solution to that problem? We may be confident that, when we have done it, we shall be able to establish our system of high productivity and equitable exchange on a permanent and enduring basis. It will not be done this year, or, perhaps, in this generation; it will not be done overnight by any sleight of hand because we must reach deep down into the hearts and souls of men to make them realize what their experience means.

WE ARE accustomed to consider mass production as something new. We hear the standard of living mentioned as though it were a discovery of yesterday. The fact of the matter is, of course, that man's efforts to achieve mass production to enjoy a higher standard of living is an agelong story. It goes back to the first men who were able to live, not by virtue of horsepower, but by virtue of manpower. The first man roved about capable of enjoying a standard of living that was measured by his own muscular energy applied through his physical organism. He started out in the morning to accumulate enough food to carry him through the day and, if he was fortunate enough to kill an animal that had a hide, he obtained a suit of clothes that would last him for a while. Then, he had to find a shelter either in the natural clefts and caves or else build an artificial shelter; but all of the power that he had to do it with was what he could generate in his own person, man, the heat-engine.

Then, he discovered that he could multiply his productivity. Some did it by enslaving their fellow men, thus multiplying their own productivity by using the productive energy of their fellows for their own advantage. Others learned how to harness the lower animals; and think what a thrill the first man must have had upon discovering that he could leave the ox to grind the meal and supply him with food for a couple of weeks, while he took a little more time to find an animal with nice soft fur to get a suit of clothes. The concept of mass production and luxury was born at once. Of course, he did not recognize it in those terms. Up to that point, he had been fighting for only one thing, survival. Just to live was all that he had asked of the world; all of the energy that he could muster was needed for that, and no one knows how many of those who were born actually did survive, probably a very small number indeed.

HARNESSING OTHER ANIMALS INAUGURATED MASS PRODCUTION

When man learned how to harness the other animals, he embarked upon the career of mass production that we have brought to such a high stage today. He then began to climb higher up in his standard of living and added convenience, comfort, and, eventually, luxury to his requirements of survival. And let me point out that those standards are not static. What seemed luxurious to the early man today seems to us unspeakably crude and what seems to us to be the luxury of today will become the necessity of the next generation. Consider your own experience. The telephone, the motorcar, central heating in your homes, to say nothing of the radio; and now we are coming into air conditioning and a host of new facilities. We have seen the luxuries of yesterday become the necessities of today and we shall see the luxuries of today become the necessities of tomorrow, because man never has stopped in his eternal struggle to multiply his productivity. Even though he may have been deluded and misled for a moment, in the long run he comes to appreciate that, only by multiplying his productivity, can he have an abundance of the things needed to make life easier and more comfortable and more enjoyable. Although he may be deceived for the moment, he knows deep down inside of himself that it is not possible to achieve an abundance for all by dividing less and less among more and more. At times, that fundamental truth passes under a cloud. Today, in some degree we are under such a cloud, but I have a profound faith that, away down inside of him when he once gets his grip on this issue, the American, at least, will learn and remember that the sole foundation for a greater abundance for all is a continually increasing production of those things that constitute real wealth.

Of course, when these first men learned how to multiply their productivity by harnessing the animal, they also discovered other forces in the world about them which might be harnessed. Some of the more sagacious discovered that the motion of the air created the wind and could be made to turn wheels and do things for them. Then, some of them discovered a strange mysterious force that we call gravity but that they knew simply as falling water seeking lower levels. They learned to harness it. Then, they had manpower and animal power, wind power and water power for ages and ages and ages, and that was all they had to work with. The standard of living that man was able to enjoy was strictly limited by his command over those powers that would multiply his own muscular energy.

Presented at the Semi-Annual Meeting, Detroit, Mich., May 17–21, 1937, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

DISCOVERY OF STEAM POWER AND ITS APPLICATION TO MACHINES

Only 150 years ago or thereabouts, man discovered how to use the expansive power of steam, and, measuring my words, I believe that this discovery probably was the most far-reaching and significant event in the history of man's conquest of the material world. When he learned the secret of that power and how to unlock energy that had been stored in the earth for aeons, he put his foot upon the ladder that has enabled him to climb so fast and so high in his standard of living.

To me, it is the outstanding miracle of history, so far as the material world is concerned, to contemplate the enormous change that has taken place in the destinies of man's material existence in the mere twinkling of an eye. For what is 150 years in the history of the race? When man was given that power, he was given the key to unlock, and leave open forever, the door of plenty. The only reason that he has not done it is because the sister sciences of sociology and economics and all the other sciences have not been able to condition human nature to make the best use of that key which physical science put into the hands of humanity 150 years ago. Human nature is not, and has not yet been, equal to the task of using to perfection the gift that was put in its hands, but I profoundly believe that, in the application of power through machinery to multiply the productivity of man, we shall yet effect once and for all upon this planet the complete rout of poverty and want and scarcity. It is in the woods. We just do not know yet how to manage it. We have not conditioned our own natures as yet to do the job, but we shall do it without any question.

Of course, when man began to apply power, he needed machines with which to do it, and I take it as an interesting commentary that here, tonight, you are honoring as your chosen guests two men who are symbolic of that union. In Dr. Dow, you have a man who has devoted his life to increasing the efficiency with which man has been able to generate and convert the power that he needs to multiply his own energy, and, in Mr. Ford, you have the industrialist who has taken power and applied it to a specific task of multiplying the productivity of man, both in the creation of new commodities and achieving a greater efficiency of transportation. Here we have the generation of power and the application of power, the two essential purposes embodied in your two guests tonight.

When we had this power applied through machines, we opened a Pandora's box of new troubles. That is the great trouble with man, he solves all his problems by creating new ones. When I go around the country today and listen to my friends tell about the problems under which we bow down, oppressed, I cannot help recalling those days for which they yearn in the 1920's. I do not remember that any one then thought that everything was jake. It seems to me that we had many problems then. I have forgotten just what they were, but I know they were there, because there never has been a time when man has said, "Now, everything is solved; now, we are all set; we are all happy. Everybody is making as much money as he wants and is able to get all that he wants with it and nothing is yet to be achieved." We never get that way, which is fortunate, of course. So all that I know about our human problems is that they change in nature but not in number. We always seem to have just as many problems as ever. They are just different, that is all. They wear a new mask, a new face, but the same old dull care lurks behind it.

SPECIALIZATION OF FUNCTION AND EXCHANGE OF WEALTH

When man secured power and machinery, the first difficulty that arose was specialization of function. That brought up an entirely new set of problems. Until then, every one had gotten along splendidly, because every one did just what he needed to do and he did it all. He lived a complete life to himself, made his own clothes, or they were made in his family, raised what he wanted to eat, and hammered out the crude utensils that he needed to live. Many men in this room today can remember when a very important part of that economy still existed in this country. If the individual was not complete unto himself, at least, the little village was complete unto itself. Give a man a farmer and a blacksmith and he had about all that he needed to carry on.

Then, along came power and the machine, and we lost our independence, because, if we intended to apply power to produce more efficiently and in larger volume so that we could reduce costs and make these gifts more available to more people, each of us had to take a particular job to do. One man had to lock himself in a room with blueprints and T-squares and what not, another had to go in a machine shop and machine the casting that a third man made in a foundry, another had to set the machine up, and another man had to run it, and not one of them could eat the thing that he made, neither could he wear it on his back. The result was that we became completely interdependent because of the specialization of function, and this brought us a new problem, that of exchanging our wealth.

Now, that we had learned how to create it in abundant measure, we had the job of exchanging it one with the other. If I specialized in making heels for shoes, I had to find a way of trading shoe heels for bread and cheese with the fellow who made the bread and cheese, and, incidentally, a half-dozen fellows had a finger in making the bread and cheese before it could get to me. So a new problem confronted us. While I am on that subject of exchange, I would like to stick a pin in this notion that our economy is one of production and distribution. Our economy never can be one of production and distribution, because those words imply that the aggregate production of all flows into a pool, from which some agency distributes that wealth to those who need it. And I am afraid that we have too many people in this country right now who are thinking in exactly those terms and the agency that they have elected to perform this distribution is what we call government. Now, they are trying, in Russia, to work out an economy of production and distribution, and they may succeed. Time only will tell, but, so far, we are not operating in an economy of production and distribution. We are still operating in an economy of production and exchange. The essential difference is that, in our form of economy, nobody is entitled to participate in the distribution who does not contribute to the creation of wealth. Ours then, is an economy, not of production and distribution but of production and exchange, where each man knows that his obligation is to produce something that other people want and need if he, in turn, is to get a share of what they produce. That is the reason why I have objected consistently in recent years to describing our economy as one of production and distribution. I prefer to think of it as one of production and exchange, which is what it really is. If we can once implant the idea in the American people that it is an economy of exchange, we shall be able to combat some of these notions that wealth is spun out of the empyrean blue and all that the community need do is to distribute it in proportion to need and not in proportion to effort.

DEVISING SYMBOLS FOR EFFECTUATING EXCHANGE OF WEALTH

Another evil genius escaped from Pandora's box when we learned how to multiply productivity through the application of power in machinery. We found that, if we were to effectuate this change on such a vast and infinitely complicated basis, men had to devise some tokens, some symbols by which we

could do this. Barter was out of the question. Direct trade in kind was out of the question, and man had to devise some system by which he could keep track of what he produced, and what that entitled him to of what other people produced. So, he invented money, and what trouble that has made! All this trouble has been made only because we have forgotten that money is nothing but a laundry check. I do not care how many laundry checks the Chinaman writes, what determines their value is the number of shirts that he has on the shelves. You can multiply money, which is the guinea pig of all of our economic institutions, as far as you wish but you have not increased by one iota the amount of wealth in the world, because wealth is nothing else but those things and services that are useful to and usable by men to gratify their desire for comfort, convenience, and luxury. Its sum total is measured by the aggregate of those goods and services which exist for that purpose, and I do not care how much money you print, whether it be hard money, paper money, or imaginary money, i.e., those bookkeeping entries in the bank that constitute 90 per cent of what we call money.

So long as men used money only to effectuate the change of real wealth, everything was fine, but some of the boys discovered that the important thing to the individual was to have the laundry check. Whether you had left any laundry or not, did not make any difference. So a disproportionate amount of human genius and human endeavor has gone into acquiring laundry checks. Every once in a while, too many of the boys go down to the laundry at once, and then there is the devil to pay. They find that they have made out more checks than there are shirts. To carry out the metaphor, when they find no shirts on the shelves, they go through the wringer.

All that a business depression means is that we are tearing up the laundry checks until they have some relationship to the shirts on the shelves, and, the devil of it is that it is not always the people that left the laundry that get it. Somehow or other, the fellows that have the job of writing the laundry checks manage to get in first when a shortage of real laundry exists, and that leaves all the poor fellows, who make shirts and work hard to earn shirts, free to go without their shirts and earn some new ones.

I have no intention of making light of a serious subject, but I do want to emphasize that the only thing that is wrong with our modern doctrine of multiplying productivity through the application of power and machinery is the fact that we have not yet learned how to devise a system of tokens and checks which will effect the exchange of the great wealth that we produce on an equitable basis without becoming the tool of manipulative speculation, whereby we try to acquire without the labor of creating. To say that is easy enough, but it is not easy to remedy. After all, if it is that easy to say and to see, why should we be staggered by the job of approaching a solution to that problem? We may be confident that, when we have done it, we shall be able to establish our system of high productivity and equitable exchange on a permanent and enduring basis. It will not be done this year or, perhaps, in this generation; it will not be done overnight by any sleight of hand because we must reach deep down into the hearts and souls of men to make them realize what their experience means.

There is something of the gambler in every one of us, a beneficent trait when applied to creative purposes. We have had great gamblers in American industry whose efforts have been directed toward creative ends, and we have had many others whose gambling has been purely acquisitive and nothing else. We need the first kind of gamblers, not the second.

A business enterprise is nothing in the world but a clearing-house of services. Every businessman and every industrialist establishes one when he brings together two groups of people, one called employees and the other called customers, and lets them effectuate the exchange of their services one with the other. That is what business and industry are and the wise businessman and farseeing industrialist is he who does that, recognizing that what we call profit is but the wages of enterprise. His reward for having had the vision to see a need or a new service, to apply a new scientific discovery to useful purposes, to integrate that into a practical operating unit, and to bring together the two groups of people, one employees and the other customers, and to effectuate an exchange of the new services that grew out of his vision and energy is the profit that he reaps from his enterprise. Under our system, he will be able to reap that reward in the same measure only so long as he is able to render that service more efficiently than someone else. All around us today, we see some of the best minds trying to lick the rule by which our whole organism has its existence and being, trying to get away from competition. When we do that, we are trying to destroy the vital principle that makes possible that system under which we are working.

IMPORTANCE OF MERCHANDISING IN AMERICAN BUSINESS

That this thing we call merchandising has become so important a part of the American scene is not an accident. When we step up our production of wealth tremendously, we must step up the exchange of that wealth into the same tempo. If men who are employed in one business organization are to exchange their services with those employed in another organization, we must find a way of letting each know quickly and consistently and constantly, what the other has to offer. Is not this particularly true in a period when new scientific discoveries and new technology are giving us new commodities and new services that we never heard of the day before yesterday? We cannot go on multiplying new forms of service unless, at the same time, we just as rapidly inform men of the new services that are available for their use. Of what use would be all the motorcars built in Detroit if the American people had never heard about the motorcar and what it could do for them. How long would it take the motorcar to filter into the consciousness of the American people if we did not deliberately go out and tell them about it and get them to know about it and stimulate their desire for it? See how important that is as we rise in the standard of living. As long as men are living on a plane of bare survival, as long as their productivity is equal only to creating the necessities of life, no need for merchandising exists. Every man knows that if he supplies the necessities of life every other man needs them. As soon as we get above the necessities of life, as soon as we have a margin of income to spend for something besides them, then comes the question of choice and men say, "Why, I have surplus income; my productivity has increased. I have more money than I need for bare necessities, what am I going to do with it? Get a new automobile, get a radio, take a trip to Europe?" Back in the old days, the man who ran the general store in the town knew not only what everybody in his town would buy during a year but also about how much. He knew that farmer Jones down the road had a couple of hogs that would run just about so much in terms of clothes and what not, and he knew someone else whose hens were laying at about this rate and the eggs would be good for just about so many calico dresses and he became the exchange and purchasing agent for the community. No problem of merchandising there.

But consider your department store here today. When your wives go out today with your pay envelopes they are not out

to get the bare necessities of life. They are going out to expose your productive power to temptation. They do not know what they want. All they know is that they have a certain amount of what they call buying power, which is your productivity, and they have a check on the community to demand the services of other people in the form of commodities up to a certain amount. They do not say, "I must have this, that, and the other thing to live and hold the family together." No, not any more. They go out and say, "Well, I wonder, shall I get a permanent, a new dress, or a couple of matinee tickets?" We have choice, and, the minute you begin to have choice, you must have merchandising. All of this promotion, this advertising, this salesmanship is just as essential to maintain the tempo of merchandising as the assembly line is to maintain the tempo of production, and, only in proportion as we keep merchandising speeded up to the right tempo, shall we be able to keep production speeded up to that tempo. That the Americans are great advertisers is not an accident. It is not because of any peculiar qualities inherent to ourselves or anything like that. We have become the people that we are because of our geographical situation, our natural resources, and the development of power and machinery; we are the people who have carried productivity of the things that men want and need to the highest degree, and we will be compelled to carry the whole science and practice of merchandising to the same high degree if we are to maintain our productivity.

RAISING STANDARDS OF LIVING BY CREATING NEW EMPLOYMENT

That is the picture of what I call mass production. Every workman has multiplied his productivity so that he could raise the standard of living and have more things for a given expenditure of his efforts. In doing this, we are not only making available to ourselves more of the things that we want and need, thereby enabling us to raise our standard of living, but we constantly are creating new employment and new services for our fellow men. There never was a more vicious fallacy foisted upon the American people than the idea that technological progress breeds unemployment, and its acceptance by people who should know better is one of the saddest aspects of our time. Here is neither the time nor the place to go into a long, factual, and analytical dissertation on that subject. I do want to cite the experience of one industry which means so much to this community. In 1900, 36 years ago, there were eight thousand automobiles in the United States; today, there are twenty-eight million. That was the result of technological progress carried to the nth power. How many men do you suppose that threw out of work? Let us say that some coachmen could not learn to drive a car and that there were some others. Go ahead, add them all up; but you must set off against them, one out of every seven persons employed in the United States today who has his job by virtue of automotive transportation, directly or indirectly.

Let your imagination go for a minute. Do not confine it to the walls of the plants in Detroit and Flint and Pontiac and all around here. Go to Youngstown, Pittsburgh, and elsewhere. See the raw materials. Go to Texas and California and Oklahoma and see them taking petroleum from the ground and, then, follow it to the refinery. See it being converted into gasoline and lubricants and follow them as they are being transported by rail and by pipe line and by steamship. Go to the many filling stations throughout the country today and think of the families dependent upon them. Every one owes its existence to automotive transportation. Go into the service and the storage garages. How much real-estate tax do you suppose is paid in Detroit by the automotive industry, entirely aside from any land that may be occupied by automobile plants? Take every filling station, every garage, every parking lot. Go ahead, you do the rest. How many men are engaged in writing insurance on automobiles? How many men are engaged in the sales departments and in the retail shops to sell automobiles and their accessories? Let your imagination go, and, when you are all through, how many men are building, maintaining, improving, and patrolling the highways? When you are all through looking for the men whose jobs are dependent upon that increase from eight thousand to twenty-eight million cars in 36 years, you will have accounted for one out of every seven gainfully employed in the United States. That same principle can be applied to any other industry. It will be on a smaller scale, perhaps, but it is there. This present increase in productivity is made possible by the application of power through machinery, and makes jobs and new services as well as bringing within reach of each individual, more of those things that he wants to make life worth-while. Man has never yet discovered any way to a higher standard of living except by finding out how to produce more of the goods and services that he wants and desires and needs per unit of human energy, and, only in proportion as he does that, will it be possible for him to climb to higher standards not only of material but also of cultural living.

I wish some scholar would take this thesis and work it up. I am not equal to it. I want some scholar to take the proposition that you can measure the height of a civilization by the relative number of people employed in rendering services as compared to those producing goods. I believe that you could show that the highest civilization is achieved when the largest proportion of the people is engaged in rendering services rather than in producing material things. The more that we can liberate men from the production of the bare material things that we need for existence, the more we shall free the hearts and the minds and the souls of men for the arts, for music, for poetry, for literature, for the drama, and for all of those things that we are accustomed to consider as representing the spiritual and cultural development of men. That word services covers everything from bellhops to writers of symphonies, teachers, preachers, practitioners of medicine, writers, musicians—all these render services. Our own history shows us, that in the last 50 years, the increase in the percentage of those employed who are engaged in rendering some kind of services has been great. While we may have reduced the number of those engaged in producing certain commodities, and even this is questionable considering the greater volume that is produced, we have tremendously increased the number of those rendering services of some kind. As I ran over that picture of the automotive industry, you remember how many of them, the filling station, the storage garage, the service garage, were services. Writing insurance is service. When fewer men are needed to produce the commodities that we need in our modern life, we will find that, out of our abundance, we are able to employ more of them to render those services that make life better and more pleasant, and thereby give us a chance to enjoy our leisure instead of having it hang upon our hands.

That is the ultimate destiny of the thing that we call mass production, and if by one stroke of the pen, we could solve those problems of producing the materials and commodities that we need to live by, we should have a world in which there would be many things which would be far more interesting to do, perhaps, than those that we have done in the past. Emancipation of man from the drudgery of eking out a bare existence is the mission of mass production, and that is just another way of describing a constant climb to higher standards of living.

The Century's GREAT INVENTIONS

By D. S. KIMBALL

CORNELL UNIVERSITY, ITHACA, N. Y

PARTLY because they are so numerous and partly because they so frequently interlock and overlap, writing a brief account of the inventions of the last century has been a somewhat difficult task. Thus, the automobile, usually regarded as a great invention, includes several other equally important inventions which have made it possible, namely, the internal-combustion engine, the modern ball or roller bearing, and the pneumatic tire, to mention only a few. Invention has been defined as "any new and useful art, machine, manufacture, or composition of matter or any new and useful improvement on any art, machine, manufacture, or composition of matter not before known or used." Accepting this liberal definition, the automobile and similar constructions may be classified as inventions as may be also new materials and processes.

TABLE 1 INVENTIONS CLASSIFIED ACCORDING TO FIELDS OF USEFUL PROGRESS

Power generation and transmission		Transportation
Steam engine	Electric induction	Locomotive
Condenser	Electric generator	Stephenson link
Slide valve	Electric motor	Air brake
Corliss valve	Transformer	Pullman car
Compounding	Electric light	Block signaling
Shaft governor	Storage battery	Steamship
Water-tube boiler	Refrigeration	Screw propeller
Modern steam generator	Internal-combustion engine	Stabilizer
Stoker	Diesel engine	Gyrocompass
Oil fuel	Steam turbine	Modern roads
Mercury boiler	Electronics	Road-making machinery
Centrifugal pump	Air conditioning	Automobile
Gas producer		Dirigible
		Airplane
Machinery of production		Cantilever bridge
Lathe	Precision measurements	Suspension bridge
Planing machine	Interchangeable manufacturing	Elevator
Boring machine	Sewing machine	
Drilling machine	Knitting machine	Sanitation
Grinding machine	Ball and roller bearings	Filtration of water supply
Turret lathe	Electric welding	Modern plumbing
Automatic lathe		Sewage disposal
Automatic machinery		
Gas welding		Communication
		Telegraph
War	Agriculture	Telephone
Breech-loading rifle	Reaper	Radio
Revolver	Harvester	Television
Repeating rifle	Combine	Rotary printing press
Machine gun	Seed planter	Linotype
Armored ship	Potato planter	Monotype
Gun turret	Potato digger	Typewriter
Submarine	Tractor	Business machines
Torpedo	Cotton gin	Radio compass
Tank	Chemical fertilizer	Photography
Lethal gas	Canning of food	Phonograph
		Motion pictures
	Materials	
Bessemer steel	Aluminum	Vulcanized rubber
Open-hearth steel	Alloy cutting steels	Synthetic materials, such as rayon and plastics
Electric-furnace steel	Alloy construction materials	

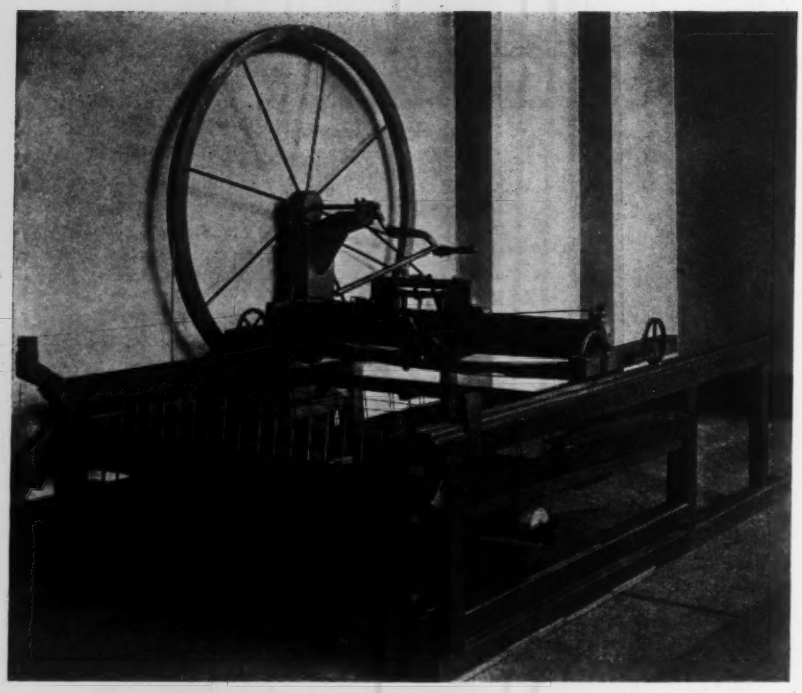
INVENTIONS, ANCIENT AND MODERN

Furthermore, to get a clear view of inventive progress in the last century is difficult without considering our inheritances from the past. The story of man's rise from savagery to civilization is the story of his invention of new tools and processes, the story of industrial progress from the stone hatchet to the *China Clipper*. Therefore, recapitulating briefly the inventive contributions that past centuries have made and of which we are the inheritors and beneficiaries may not be amiss.

The ancient world gave us such fundamental inventions as the lever, wedge, screw, wheel and axle, paper, hand spinning and weaving, and, most important of all, the alphabet. The ancients also invented the simple handicraft tools such as the axe, saw, hoe, and similar implements, and they also invented the ship. To these, the middle ages added such inventions as the blast furnace, the puddle forge, charcoal steel, gearing, belt and pulley, gunpowder, the balloon, the mariner's compass, the telescope, the microscope, the art of printing, the clock, the windmill, the water wheel, and the plunger pump, and revived the inductive method of reasoning through the work of Roger Bacon. Many machines and appliances were built in these long periods, particularly for war purposes, and much inventive speculation was indulged in, but practical results up to the end of the eighteenth century were meager indeed compared to progress since. This seems remarkable when consideration is given to the high intelligence manifested by older civilizations and to the fact that the general inventive darkness of past centuries was illuminated occasionally by such meteoric figures as Hero, Archimedes, and Leonardo da Vinci. And it seems even more remarkable when note is taken of the development of architecture in all periods, an art that certainly requires high inventive genius. The influence of philosophical thought, the repressive influences of the church, and reliance upon slave labor may all have had a share in retarding mechanical invention; certainly it was not lack of intelligence. This interesting question, however, is one for the psychologist and historian and is outside the scope of this paper.

Near the end of the eighteenth century, three inventions that ushered in a new industrial world and have changed many of our social and political conceptions, appeared in England. These were Hargreaves' spinning jenny, Watt's steam engine, and Maudsley's all-metal screw-cutting lathe. Much preliminary experimentation had, of course, preceded each of these three machines, and many improvements quickly followed, but these machines are outstanding in that they were successful practically and were the forerunners of our modern era. Their character should be carefully noted. All tools involve what has been called "transfer of skill." That is, they enable a man of inferior skill to perform, with their aid, operations that, without them, would require a workman of superior skill. Under former and simple methods of spinning, the machine was

Presented at the centennial celebration of the founding of the American patent system, Washington, D. C., Nov. 23, 1936.



HARGREAVES' SPINNING JENNY

an aid to the worker's skill, but almost anyone could spin with the Hargreaves machine. The Maudsley lathe made a similar advance in machine tools. The true significance of the industrial revolution is that, prior to it, the tool was an adjunct to the skill of the worker, whereas the great inventions of this period carried transfer of skill to the point where the skill of the worker became an adjunct to the tool or machine. The steam engine supplied a very ancient need, namely, ample power that could be generated at any place.

To make a coherent analysis or visual picture of the vast array of the mechanical inventions that have appeared since the industrial revolution is difficult, and, furthermore, the fact should be remembered that the sciences of physics, chemistry, geology, and biology have all made enormous strides since then and that, from research in those fields, many really great inventions have appeared. Thus, electrical engineering sprang from physics, and chemistry has provided many new and useful materials and processes. The best approach that I could devise was to classify inventions under the most important fields of industrial progress, namely, power generation and transmission, machinery of production, transportation, communication, materials, agriculture, sanitation, and war. Preventive medicine should probably also be included, as many really great inventions have appeared in that field, but they are, in general, of a borderline character. Here, again, medicine owes much to other sciences such as physics from which came the X-ray. Table 1 is an attempt at such a classification. No effort has been made to make it exhaustive, and many important inventions, necessarily, are not listed. The intention was to show only the high spots of progress in each field, and, no doubt, some of them have been overlooked. As has been noted, distinguishing between true invention and application or adaptation and also between true invention and combinations of inventions as in the case of the automobile, automatic lathe, and similar machines, also is often difficult. The classification must, therefore, be considered only as suggestive of inventive progress.

To select what might be considered as the greatest of inventions from this list would be difficult indeed. The reciprocating steam engine would no doubt be selected for this honor by many because it has made so many other inventions practical possibilities. Undoubtedly, it is one of the greatest if not the greatest invention of all time, but its glory is already paling before the internal-combustion engine and the steam turbine.

INVENTION'S EFFECT UPON CIVILIZATION

Considering the effect of each classification upon our civilization may be more enlightening. Power generation and transmission have furnished us with abundant power at any desired point and relieved both man and beast of an immense amount of toil and drudgery. Machinery of production including primarily the "master tools of industry," commonly called machine tools, has enabled us to satisfy our industrial needs as no other nation has even approximated. The accuracy and productivity of our equipment in this field are almost beyond belief.

Our machinery of transportation has made remote countries near neighbors and made the world's products available in our markets. The locomotive, the steamship, the automobile, and the airplane have made travel sure, swift, and cheap. Unlike our forefathers, who often never went beyond the horizon of their native town, millions of our citizens have toured Europe and, if the present trend continues, a large part of our population will be found in summer, at least, touring the United States in trailers.

Machinery of communication has abolished time and space so far as the transmission of information is concerned. The poorest man, almost, has the world's happenings in his morning paper. Unfortunately, these facilities also furnish a grand medium for the spreading of propaganda and, as a consequence, our knowledge does not always grow in the same proportion as our information.

The advance in the production of old materials and the development of new processes and industrial products has been phenomenal. This is particularly true of synthetic products, such as rayon and the new plastics, which are the direct result of chemical research. Materials have always been the index of advance in civilization as illustrated by the use of such terms as the stone age, bronze age, age of iron, and age of steel. Is the next index to be one of the new mineral alloys or one of the new synthetic materials now making such progress, or will it be the age of synthetic foods and synthetic clothes? Who knows the correct answer?

Agricultural machinery, like industrial machinery, has done much to emancipate man and beast from labor and has given the farmer increased capacity, and scientific agriculture has added much to his knowledge and efficiency. In this field, scientific research and inventions are hard to separate.

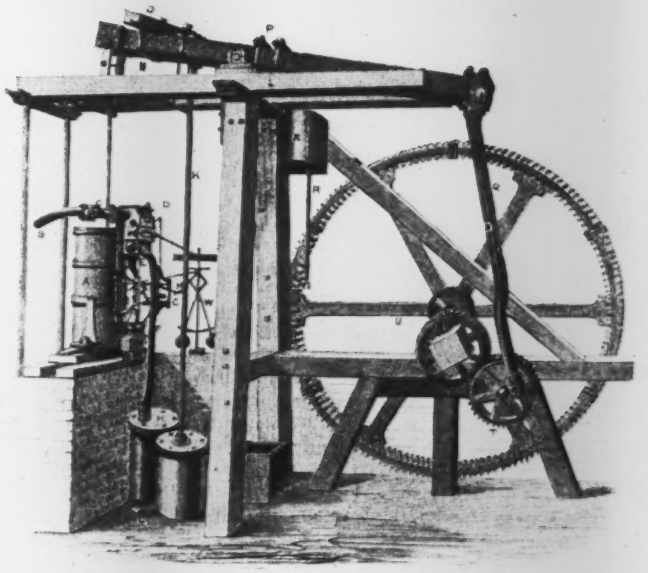
The inventions in the field of modern sanitation are among the greatest blessings that the engineer and scientist have conferred upon humanity. The abolition of epidemics because of pure water supply and modern sewage systems, and the general safety against epidemic diseases in city and country make life in the preceding centuries look precarious and uninviting. The humble water-sealed kitchen and toilet trap should rank very high in the scale of modern inventions. As to warlike inventions, perhaps the less said the better. Interesting, ingenious, and dreadfully efficient, they certainly are, but the world would

be happier if inventive genius were employed in other directions. And yet, a great armored battleship is the most complicated machine that the human mind has as yet devised. No other single piece of construction demonstrates so fully the wonderful possibilities of the human mind.

INCREASED NATIONAL WEALTH, BETTER STANDARDS OF LIVING, LARGER INDUSTRIAL UNITS

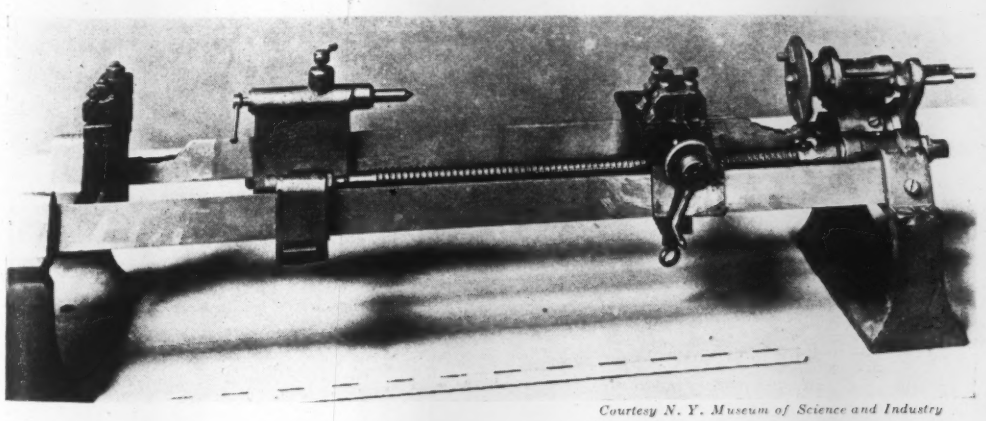
The net result of the use of these new tools and processes has been a great increase in our national wealth and a rise in our standards of living beyond that of any people at any time. This follows axiomatically, since these new methods are for the most part both laborsaving and timesaving devices so that the output of the worker per unit of time is greatly increased. Thus, the person who operates a sewing machine can do far more sewing per unit of time than she can with the hand needle, although the work of operating the machine for a given time may be as great or greater than in hand sewing. If the machine is power-driven, it will also be a laborsaving tool. Even handicraft tools are essentially timesaving devices. The census of 1850 records the national wealth as $7,135,780,228 and the per capita wealth as $308. The census of 1930 lists the national wealth as $329,700,000,000 and the per-capita wealth as $2677. The United States, with about 7 per cent of the world's population, owns half the world's communication facilities and nearly half the world's railways and has 1 automobile for every 5 persons, whereas the four other leading nations have 1 for every 50; 1 telephone for every 7 persons as compared with 1 for each 35 in the other leading four nations; and 1 radio for every 6 persons as against 1 for every 17 in the same lands. How could all this have been accomplished except through the application of these great inventions to our unparalleled national resources?

Most remarkable also has been the rapid growth in size of industrial units made possible by the advance in science and technology and the invention of new tools and methods. The reciprocating steam engine after 80 years of development attained 1400 hp, as exemplified by the great Corliss engine exhibited at the Philadelphia Centennial Exposition of 1876. But, in 1900, 24 years afterward, central-station engines of 8000 hp and marine engines of 10,000 hp marked the meridian of the reciprocating engine. The steam turbine, from its inception barely 50 years ago, has made phenomenal progress in size, single-cylinder units having been constructed to develop 80,000 hp and compound units of 200,000 hp being now in operation and the end is not yet. The internal-combustion engine, also about half a century old, is now constructed with as many as eight cylinders, each of which develops 2800 hp. The locomotive, in the same period of time, has grown from a weight of 35 tons to 350 and is a most impressive affair. The single-screw, 7400-ton British steamship *Servia* of 1881 was 515 ft long, and was equipped with engines of 12,000 hp. The *Queen Mary* is 1019 ft long, her tonnage is 77,500, and she is propelled by four screws, each weighing 35 tons and each driven by a 50,000-hp geared turbine. To build and launch such a hull is an accomplishment, but to launch such a hull into a pond little wider than the length of the ship is something for the layman to ponder. Lastly, the airplane, the invention of yesterday, exhibits the most startling growth of any of these modern marvels. One of the Pan American clippers weighs 50,000 lb, is driven by 3200-hp engines, and can make a non-stop flight of 3000 miles at the rate of $2^1/_2$ mpm. Back of all these great developments are many new and ingenious inventions. Thus, the machinery for making turbine blades would have been considered very remarkable 50 years ago.



WATT'S FIRST ROTARY ENGINE

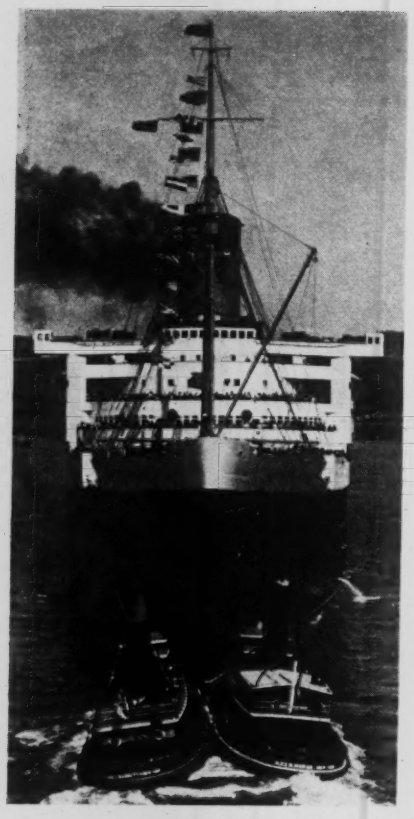
(*A*, steam cylinder; *B*, steam pipe; *C*, throttle valve; *D*, steam valve; *E*, eduction valve; *F*, eduction pipe; *G*, valve gearing; *H*, condenser; *I*, air pump; *K*, air-pump rod; *L*, foot valve; *M*, hand-gear tappet rod; *N*, parallel motion; *O*, balance weight; *P*, rocking beam; *Q*, connecting rod; *R*, feed pump rod; *S*, sunwheel; *T*, planet wheel; *U*, flywheel; *W*, governor; *X*, feedwater cistern. Illustration is from Smiles's "Lives of Engineers.")



Courtesy N. Y. Museum of Science and Industry

MAUDSLEY'S SCREW-CUTTING LATHES

At the same time, the industrial system has become so complex and delicate that it is easily thrown out of balance, and depressions, which are a very old phenomena, become increasingly violent and prolonged. During such periods, the cry against technological unemployment and scientific progress is raised, ignoring the self-evident fact that we have reached the economic level we now occupy only through the use of these inventions and equally ignoring the fact that, even in the depths of this depres-



Courtesy Cunard White Star, Ltd.

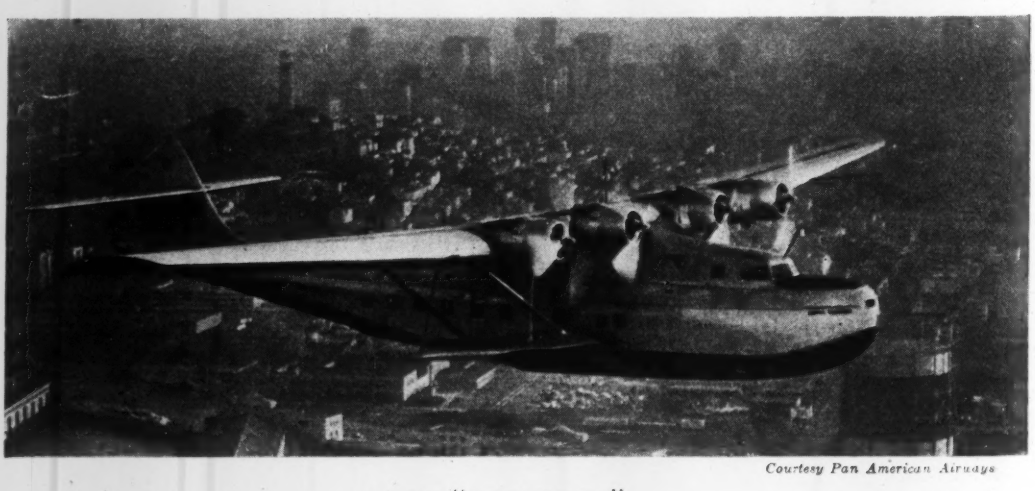
THE "QUEEN MARY"

sion, we were, as a people, immensely better off than the average worker in the best of times before the industrial revolution. I would ask the critics of scientific advance to strike from the list of great inventions those that, in their opinion, the world would be better without. No well-informed person would eliminate a single item excepting the weapons of war.

Theoretically, all should be greatly benefited by advances in industrial and agricultural production, and, in the long run, they are. However, such advances may, and often do, displace some workers or even eliminate their calling. Human progress apparently cannot take place without suffering on the part of some one. When the industrial field was simple and more flexible, this displacement of workers was not so much of a problem, but the intensity and complexity of modern industry is now such that technological advance must be measured against the human problems involved. We must make haste more slowly, for new industrial processes do not carry with them, inherently, any influences tending to rearrange the distribution of the increased profits derived from them or to offset the effects of the fierce competition rendered possible because of increase in productive capacity. Invention and its results always act quickly; social and political changes, much more slowly. The law of supply and demand operated quickly under the older and simpler methods. Complexity of modern methods tends to make these laws act much more sluggishly.

The great problem that confronts us is not that of production but that of economic distribution. We can, even now, manufacture enough goods and grow enough food to maintain a fair standard of living for all, but all of the new productive processes that may be invented will throw little light on the problem of why, in many places at the same time, storehouses are filled with raw material, idle factories equipped with the finest tools the world has ever seen, and people walking the streets in idleness yet willing to work. We have not, as yet, learned to use wisely these great improvements in production that alone can bestow upon us universal well-being where all shall have sufficient food, clothes, and shelter and some of the good things of life, and this problem cannot be solved by the simple expedient of increased production. The questions still remain of competition, taxation, governmental expenditures, tariff and monetary problems, immigration, and a dozen other political and economic factors that, taken as a group, appear to resist a solution on which our best minds will agree. What is most needed is scientific distribution of the fruits of labor, not only in the industrial field but markedly so in agriculture where the cost of marketing is often a disgrace to our intelligence. The problem of production is fairly well solved; that of equitable and stable methods of distribution awaits solution.

One other phase of invention, to which I would briefly refer, remains. Invention is distinctly personal in character. All of the great inventions are closely connected with the work of some individual. I have purposely refrained from listing these names partly because the list is so long, and partly because, in some instances, the credit for invention is somewhat controversial. Nevertheless, the fact remains that the race always makes progress through the individual and not through the mass. Inventive genius is a rare plant that does not flourish under glass or among the dense undergrowth. It must have freedom and, in this respect, is much like scientific research. The great inventions and improvements of the last 150 years have been the work of scientists, inventors, and engineers working freely and untrammeled by restrictive influences of any kind save their own regard for accuracy and truth. I would view with alarm, therefore, any effort on the part of state, church, engineering society, or labor union to restrict, in any way, the growth of science and invention and the economic improvements that flow therefrom. We still have a long way to go before we shall be able to produce the abundance necessary to secure the universal well-being that we should all like to see. As has been noted, we need more intelligent use of our productive powers and more humane application of advanced methods, but to blame our economic ills on overproduction is to deny the basic fact of all history. Man's progress economically and socially has been in direct proportion as he has improved his tools of production. Primitive tools are synonymous with savagery and slavery, and the index of a higher life is the level to which we can raise our science and technology.



Courtesy Pan American Airways

THE "CHINA CLIPPER"

HOW FAST IS TOO SLOW?

By L. K. SILLCOX

THE NEW YORK AIR BRAKE COMPANY, WATERTOWN, N. Y.

ATTAINMENT of new ultrahigh railroad speeds seems now assured, the record of top speeds having been raised in three years from a range of 80 to 90 mph to 100 to 120. Stephenson nearly defeated his object, when advocating the first steam railroad, by asserting that trains could be moved at a rate of 12 mph. This was soon accomplished, and then began the demand for higher speed. Today, with trains running regularly at 80 to 90 mph, the cry still continues and increases in a direct ratio with the advance in speed.

Railroad management recognizes its responsibility in complying with all reasonable demands of the public, among which the requirement for accelerated service appears most prominent. The question to be answered is whether or not compliance is practicable. If not, the demand is unreasonable. Within a certain limit, any speed, for which the public is willing to pay, is practicable. When travelers are disposed to pay for a 12-hour ride of approximately 1000 miles between New York and Chicago, they can be accommodated with as high a degree of safety as they now enjoy while making the journey in $16^1/_2$ hours. Locomotives can be built which are capable of attaining speeds of 100 to 120 mph with moderate loads; and we can conceive of a railroad so devised as to admit of these speeds with the most desirable standards of safety maintained. That such a line can be built and operated so as to render a fair return upon the investment is a problem for real study in the face of the popularity of cheap fares for which the public is just now showing tremendous preference. On the other hand, referring to a few of the reasons that render attaining such speeds difficult, without tremendous expense, may not be out of place.

FIG. 1 MAST-TYPE LIGHT SIGNALS OF THE TYPE SHOWN AND THE AUTOMATIC TRAIN STOP HAVE DONE MUCH TO EXPEDITE MOVEMENT OF TRAINS

BRAKING FOR HIGH SPEEDS

An outstanding, perhaps the most important, element to be considered, when starting a train, is the ability to stop it. Under favorable conditions and with the most modern power-brake equipment acting upon all the wheels, a train, running at 100 mph, when the application of the brakes was initiated from the locomotive, would have traveled 1300 ft at the end of 10 sec and would still be traveling at 72 mph. It would be brought to a stop in about 1300 ft more or 2600 ft in all. Braking performance of this nature contemplates a delay of 2 sec from the instant of brake-valve-handle movement to the point of equivalent instantaneous maximum brake-cylinder-pressure development and a maintained rate of retardation of approximately $3^1/_2$ mph per sec, the average speed during the time of braking being 55 per cent of the initial speed, a ratio that has been shown to be approximately correct within this speed range for heavily braked units. This retardation rate contemplates reasonable maximum utilization of available wheel-rail adhesion on good rails. No braking standard of this order has been realized since no equipment has, to date, been fitted with a brake-foundation-gear arrangement that will apply the necessary forces, distributed over a sufficient number of wheels to relieve any individual wheel or brake shoe of excessive temperature development. Under the best actual conditions now existing with conventional brake equipment, the train at the end of 22 sec, would be moving at 72 mph and would have to travel about 4800 ft before stopping. With this fact staring us in the face, discussing the running of trains at such speed in connection with ordinary passenger and freight traffic seems a waste of time, unless adequate measures are taken in advance to govern the movement of the faster schedules.

An ideal railroad for ultrahigh-speed runs should be perfectly level and straight, with a substantial and well-drained roadbed and heavy track, no grade crossings or openings to invite trespassers, bridges with floors as solid as the roadbed itself, and stations planned so that no passenger could ever set foot on the track. These tracks would be devoted exclusively to ultrahigh-speed trains and located at a sufficient distance from all other tracks and from each other to avoid the danger, ever-present under existing conditions, of an accident on one track causing a worse one on another. Add to this, a perfect system of train control and cab signals. Then, with equipment constructed of the most suitable and best materials and under the most rigid inspection, traveling on such a track at schedule speeds even higher than 100 to 120 mph is possible with comparative safety. All of these requirements can be met, but only with unlimited capital, and, perhaps, this ideal will never be realized.

Leaving the question of unreasonably high speeds to theorists, and to the future, is it practicable to increase the average speed on what might be termed the best runs, such as those handled by the *Century*, *Broadway*, *Olympian*, *Congressional*, *Pioneer*, and other limiteds? Assuming 50 mph as the present general average and 60 mph as a special average, can these speeds be increased 25 per cent to 63 and 75 mph, and to what extent would this involve ordinary or local traffic? What system and appliances are necessary to bring about such a con-

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dition? Are the roadbed and track safe for such accelerated schedules, and, if not, can they be made so at reasonable expense?

MODERN TRACK AND MOTIVE-POWER STANDARDS

Roadbed and track are the first essentials to high-speed running; and, since improvements now being made on most trunk lines are fast rendering them safer for a speed of 80 mph, in so far as track is concerned, than they formerly were for 60 mph, little attention need be devoted to an analysis of this aspect. In fact, many administrations, such as the Pennsylvania, New York Central, Burlington, Union Pacific, Santa Fe, and Milwaukee, have already reached that condition. A typical example of modern track construction is presented in Fig. 1. Better bridges, improved ballast, perfected drainage, and heavier rails have been adopted, and all parts of the track proper have been improved. The number of crossties per unit of track length has been materially increased, dangerous curves have been straightened or entirely eliminated, grade crossings are being abolished or more securely guarded, and switches are being improved and protected.

Few persons, other than the men who have brought the modern locomotive to its present development, appreciate the potentialities of the machine or the enormous quantities of power developed daily by this type of prime mover. What development in the locomotive is needed to increase the average train speed by 25 per cent is a story in itself. Not many years ago, the word, "locomotive," was synonymous with a portable power plant, carrying a coal-fired boiler and driven by two reciprocating steam engines. This conception is maintained as the basic power for railroads, but, late in the nineteenth century, the electric locomotive was experimentally introduced to satisfy a specific requirement.

The rapidly expanding automotive industry presented an internal-combustion engine which, passing through several stages of development for stationary industrial and marine work, ultimately emerged in suitable form for the railroads and offered a satisfactory approach to that measure of thorough dependability which is essential to railroad service. Petroleum fuels for reciprocating steam locomotives were adopted 40 years ago in territories that produced the crudes, but since no change of consequence in the locomotive itself was required to complete the conversion, merely substituting a new fuel cannot mark an era in locomotive development.

Soon the turbine electric locomotive will be operating on American railroads. This will not be the cumbersome turbine unit of the past, with a tremendous condenser and various starting and reversing complications, but a wholly new design, operating with 1500 lb per sq in. steam pressure and a temperature of 950 F, the steam being generated in a compact oil-fired boiler arrangement. As the designs of these new units are viewed without benefit of the service record of trial locomotives of this type, the prospects of highly successful use are promising indeed. Time alone will develop the measure of suitability for varied services which they may display. Still the reciprocating steam locomotive, which has performed satisfactorily for over 100 years and has survived 30 years of predicted obsolescence, is not seriously threatened. Its low first cost and relative simplicity assure its ability to compete successfully with any locomotive type yet developed, and its limit of sustained speed has not yet been reached.

SUITABILITY OF CONVENTIONAL AND ELECTRIC LOCOMOTIVES

Prospective high-speed services have produced new and unusual locomotive types. At the same time, they have brought about changes in the familiar locomotive form at an unprecedented rate. Driving wheels are higher to permit high-speed running without involving excessive piston speeds. Tenders are being built for long runs with more than double the fuel and water capacities of the locomotives that they replace. Refinements in leading-truck design insure positive stability, both in guiding and in restricting resonant effects in lateral oscillation. Attention has been given, as never before, to the counterbalancing of locomotive driving wheels to relieve deleterious track effects. Steam-locomotive braking has yet to be considered with full appreciation of the absolute necessity for maintaining a uniform standard of braking force with respect to weight upon all wheels of every high-speed train if freedom from sliding wheels is to be expected, while retarding at the maximum rate as governed by wheel-rail adhesion. This is a most important consideration, of which many competent mechanical officers have displayed an unfortunate lack of understanding.

Electric traction, whether obtained in conjunction with a remote power source or with the prime mover installed upon the locomotive bed, does offer definite advantages. A uniform propelling torque permits the application of a constant accelerating force which may be the maximum sustainable without slippage of the driving wheels. The entire adhesive weight can be utilized for traction since equipping every axle with driving motors is relatively simple, even though this is infrequently done in road service. Remote control of any number of coupled units from a single operator's station can be conveniently arranged and auxiliary drives are simplified. Both the straight and the Diesel-electric, a typical example of which is shown in Fig. 2, offer high availability as a special recommendation for their use, since periodic routine attention to the fire bed, boiler washing, and frequent replenishing of fuel and water supply are eliminated.

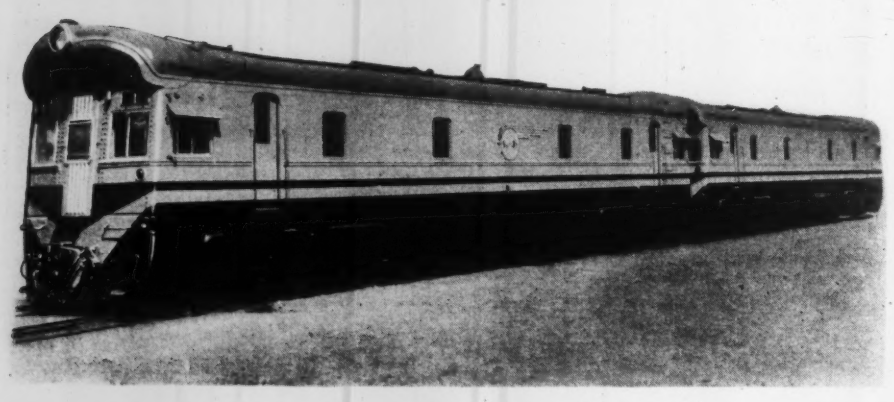

FIG. 2 DIESEL-ELECTRIC TRAIN USED BY THE SANTA FE LINES

ECONOMICS OF LOCOMOTIVE SELECTION

Selection of a locomotive type for any service is a strictly economic problem, influenced, to some extent, by public preference for the motive power employed by the railroads that shippers and travelers patronize. High first cost with consequent high annual capital charges, on the one hand, is offset by a higher thermal efficiency that can be shown for the Diesel and the saving in maintenance of way and structures claimed for the straight electric as a result of its characteristic

cleanliness in operation. The high thermal efficiency of the central generating station and the efficient conversion of electrical energy to mechanical force at the rims of the wheels, where electrification of steam lines has been completed, is burdened with transmission losses in the distribution system.

The requirement for high speed has sometimes been advanced as the reason for departure from the reciprocating steam locomotive; yet, restricted speed potentialities need not be advanced as a peculiar limitation to its capabilities except, perhaps, in certain cases where extended mileage of curved track prevails. Here, the lower center of gravity of the electrically driven locomotive sometimes permits the maintenance of higher schedule speed with safety. This simplest of all constructions for railroad motive power has still so much to recommend it, that the men of vision in railroad mechanical departments will assist to their utmost in further development of the basic design, cooperating with the builders to perpetuate a form that has served so well and holds much promise in satisfying prospective needs.

With motive power capable of maintaining the average speed on the ascending grades existing on nearly all railroads, advancing the average speed to 80 mph appears possible without any actual increase in the rate that is being reached daily, at least for short distances. More power in the locomotive is really needed rather than a higher top speed and this can be done. Otherwise, an increase of 25 per cent in the average rate means a top speed that may go beyond the reasonably safe limit for many existing routes. In other words, the best way to increase the speed is by sustaining it throughout the run.

Next in order and importance, after getting the locomotive to give the desired speed, comes the brake to control it. Notwithstanding the wonders already achieved, much remains to be realized in this direction, as has been demonstrated on the few successfully braked trains now in ultrahigh-speed operation. Trials have demonstrated that, at 100 mph, a braking force, which is double that usually employed on conventional trains operating at 60 mph can be used, if properly controlled, without wheel sliding, and emergency stopping distances, no longer than the minimum attainable, should be considered. That force must act to produce a uniform retarding force in relation to the weight borne by every axle. In addition, an automatic retardation-control device is needed to regulate brake-shoe pressure according to its effectiveness at every stage of the stop so as to avoid sliding of the wheels and consequent loss of efficiency. Thus, all parts of the brake and running gear must be strengthened to withstand the increased force to be applied. For emergency stops, a positive and ample supply of sand must be applied automatically and simultaneously with the air brake under all wheels except those of locomotive leading trucks.

SAFETY AND PARALLEL-TRACK HAZARDS

The next problem is to remove, as far as possible, every known danger from the path of the train and to guard against what cannot be avoided by utilizing the best appliances and construction. Wherever possible, overhead or underground passages should be provided at stations and crossings, and measures adopted to compel their use. Where grade separation of crossings is not practicable, every reasonable precaution must be taken against interference. Facing switches should be removed except where absolutely necessary, and, whenever allowed to exist, they should be protected by an interlock or electric signal, or both. All sidings should have derailing switches at the fouling point, connected with the main-track switch. At drawbridges, junctions, and all other points where the tracks must frequently be broken or obstructed, a system of interlocking switches and signals should be installed, and the entire line should be protected by some adequate system of block signals, automatic train control, or cab signals, for which the electric track circuit seems best adapted since it provides a suitable safeguard against the widest range of possible dangers and is the least dependent on human agency for faithful performance of its function. Signals should be uniform in form and meaning, and care should be taken not to multiply them needlessly. Automatic stop devices, operating in connection with all fixed signals displaying a stop indication, should apply the brakes and bring trains to rest whenever the signal indicates danger, independently of any action on the part of the engineman.

FIG. 3 AN INCREASE OF 25 PER CENT IN THROUGH PASSENGER-TRAIN SCHEDULE SPEED WILL, IN MANY CASES, REQUIRE A CORRESPONDING INCREASE IN THE SPEED OF LOCAL TRAINS IF THEY ARE NOT TO BE SHUNTED REPEATEDLY TO PASSING SIDINGS

With such improvements and with the additional safeguards that have been enumerated, railroad operation should be reasonably safe; but one of the most serious potential dangers and one that has never received the consideration which it merits remains to be met and overcome. This is the presence of passing trains, particularly freight trains, on adjoining tracks 7 ft or less away. Whatever may have been done to improve roadbed, track, signaling equipment, or motive power, efforts toward ideal safety standards cannot be completely effective while the danger exists of an obstruction being thrown on the track by a mishap to a train on an adjoining track. Whenever a fast passenger train meets and passes a freight train running on the opposite track, and this occurs many times a day on most lines, it is subject to a possible accident, even though the likelihood is remote. Many frightful mishaps have occurred from this cause and, unless a remedy is applied, their number must increase with any substantial and simultaneous advance in the density of traffic and the speed of trains. The remedy lies in one of two directions, separation of parallel tracks or positive prevention of accidents to freight trains. To carry out the latter aim, the standards in freight equipment must be raised still further. Quality rather than price must govern the selection of material for its construction. All old or weak cars and appliances must be discarded, and the freight car must be made to carry its traffic with the same degree of safety as the passenger car. Breaking apart of the train, due to deficient couplers and draft gears or unnecessarily continuing obsolete brake designs in service, form a fruitful source of trouble, and these specific elements are perhaps directly or indirectly responsi-

ble for more accidents and delays than all other details of the equipment combined. Stringent regulations have been adopted and enforced to prevent overloading and improper loading of cars, and better means have been provided for securing all freight that must be carried on gondola or flat cars; in fact, whenever passenger and freight traffic are both conducted over the same or adjacent tracks, equal care for their safe movement must be exercised.

What effect an increase of 25 per cent in passenger-train schedule speed may have on local traffic is an important consideration and can only be judged by the volume and character of the service. In many instances, speed of local passenger trains must be correspondingly increased or these trains must be shunted repeatedly to passing sidings, as in Fig. 3, to prevent interference with through-train schedules. Under such circumstances, trains would soon become bunched, and a general demoralization of the service would ensue. The speed of these trains can be increased, but the cost must be considered as vital to the question at issue, and, in this calculation, the rapid rate at which train resistance increases beyond 60 mph will serve as an important consideration.

TRAIN-RESISTANCE CHARACTERISTICS

The Davis equation for train resistance is probably the most familiar instrument employed for the calculation of effort required to propel railroad equipment. It recognizes the existence of resistance factors that apply in an orderly and predictable manner and is expressed in the general form

$$R = A + BV + CV^2 \quad [1]$$

in which

R train resistance, a definite restraining force
A, B, and C constants
V speed

More specifically, the Davis equation is presented as

$$r = 9.4/\sqrt{w} + 12.5/w + kV + k'AV^2/wn \quad [2]$$

in which

r resistance, in pounds per ton of vehicle weight
w average weight per axle, tons
k and k' constants
A projected area of largest cross section of equipment considered, in square feet
n number of axles
V speed, in miles per hour

The first two terms of Equation [2], $9.4/\sqrt{w} + 12.5/w$, assume the approximate value $1.3 + 29/w$, and the equation is so written in most applications. Under various conditions of equipment and type and location of cars in a train, k and k' have been assigned the experimentally derived values, given in Table 1, which also presents the approximate value of the constants applied to modern, high-speed, articulated trains. These define, with reasonable accuracy, the resistance components as they have been experimentally obtained. The loss in transmission of power from steam-locomotive cylinders, Diesel-engine crankshafts, or electric-locomotive current collectors to the rims of driving wheels is not included in the values given in the table but is taken as a function of motive-power efficiency.

TABLE 1 VALUES OF k AND k'

	k	k'
Steam and electric locomotives		
Conventional, nonstreamlined form	0.03	0.0024
Partially streamlined (well-faired)	0.03	0.0015
Passenger cars	0.03	0.00034
Multiple-unit cars		
Leading	0.045	0.0024
Trailing	0.045	0.00034
Motor cars	0.09	0.0024
Streamlined, articulated trains		
Leading car	0.045	0.00055
Last car	0.045	0.00025
Intermediate cars	0.045	0.00020

The Davis equation can readily be separated into its three major components:

(1) Journal and machinery resistance which is assumed to be independent of speed.

(2) Flange friction, and the oscillation, vibration, and dynamic-friction effects which vary with the first power of the speed.

(3) Air resistance which varies with some power of the speed approaching the square. No effect of side or head winds is considered in the basic equation.

The general equation for train resistance, Equation [2], shows that increased resistance with increasing speed is due principally to the effect of air drag at the exposed surfaces of the train. Thus, the force required to overcome the total resistance of a steam locomotive alone increases about two thirds between 40 and 60 mph and slightly over one and one-half times between 40 and 80 mph. At the same time, the air-resistance component of total resistance increases 80 per cent between 40 and 60 mph and 225 per cent between 40 and 80 mph. These figures relate to a steam locomotive of conventional form.

If partially streamlined like the New York Central's *Mercury* and *Commodore Vanderbilt*, or the Milwaukee's *Hiawatha*, air resistance at 40 mph is reduced almost 50 per cent and the increases with speed become 112 per cent from 40 to 60 mph and 300 per cent between 40 and 80 mph. Streamlining is effective, even though the ultimate form cannot be practicably attained. Its practical value is often overestimated, however, since the actual percentage saving in air resistance is of little meaning with respect to a locomotive hauling a train on steel rails. Relative economy in total resistance defines the actual benefit, and this is sometimes disappointing. No practicable degree of streamlining can completely offset the inevitable increase in power requirements that is made necessary as schedules are accelerated. A higher ratio of installed power to train gross weight is essential and can be provided either by larger locomotives or by reducing the weight of the train and, thus, its revenue capacity. From whatever standpoint the subject may be considered, the fact must be evident that high speed can be offered without insuperable technical difficulty—but at its price.

The question, "How fast is too slow?" must be determined by each railroad manager for himself and not by the public. The average traveler carried at 80 mph has little thought of the conditions necessary to insure his safety, a fundamental achievement of our railroads and one which, in view of the deplorable showing in other forms of high-speed transportation, the public is beginning to comprehend and value as never before. The lowest consistent fare is universally demanded by all travelers, and the volume of traffic secured is practically a function of travel cost. Hence, a balance between cost, speed, and safety must be considered. The steady increase in traffic calls for improvements in systems and appliances to give an increase in schedule speed which is consistent with safety and economy. These requirements should be met before making an attempt to increase top speeds. Every one recognizes that speed in all things is the order of the day, but genius and common sense are needful in evaluating its costs and formulating the procedure to meet this end.

MEN, MANAGEMENT, *and the* FUTURE

By F. A. MAGOUN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

PROF. GEORGE BOAS of Johns Hopkins University says that there are four methods of prognosticating the future:[1] (*a*) reasoning from cause to effect, as in applied science; (*b*) following natural cycles, as the tides, the seasons; (*c*) working out statistical probabilities, such as the expectancy of life, straw votes, or the average rainfall; and (*d*) "revelation" such as is credited to the prophets in the Bible.

In the field of industrial relations it is particularly difficult to dip into the future because there are no natural cycles, statistics are wholly unimaginative and usually unreliable save for immediate use, and "revelation" is sheer guesswork. Cause and effect would seem to promise something but is cruelly misleading because it is totally impossible to foresee the combination of causes. When Thomas Jefferson, in 1803, said, "It will be a thousand years before the territory east of the Mississippi will be completely settled," he could not possibly have foreseen what the railroad and the steamship would do to emigration. Therefore, no way is available by which to foresee now what will be the industrial consequences of new psychology, new ideas of government, or new economic relationships. But one thing does seem certain; indeed, almost certain enough to be stated as a fundamental law; survival value comes from group cooperation. Anyone who has ever lived on a farm knows that to shoot a sparrow is much easier than to shoot a crow, and the difference is entirely due to group cooperation. Also, survival is the fundamental problem of every living thing, whether it be a California redwood, the King of England, or the General Motors Corporation.

Group action is not enough; it must be intelligent group action. The average person when asked to draw a diagram illustrating how industry is organized will sketch a rectangle with capital, management, customers, and labor as the sides. After reflection, he is likely to smile knowingly and to suggest that, due to the domination of capital, the sides marked capital and management contract into a hypotenuse representing a capital-controlled management. But, after he has thought about it for a long time, he will conclude that the proper relationship can only be represented by an equilateral triangle, the sides of which are capital, customers, and labor. Superposed on the whole, and representing the interests of each should be management. If management allows capital to overexpand, sooner or later the result is bankruptcy and the structure collapses. If management is guilty of fleecing the customers, eventually the market collapses and so does the business. If management exploits labor, a day of reckoning and disastrous conflict will follow. If the interests of any side are ignored by management, the company will fail.

Clearly, the task of management is, and in future, will increasingly be, to integrate the interests of capital, customer, and labor. . . . That the necessity for employee representation in management was so long unappreciated is a commentary on our greedy short-sightedness. Capital found asserting authority over labor easy and concluded that, therefore, it need only issue orders without regard to welfare. Now . . . capital is learning what labor has yet to learn in its larger meaning; survival value comes from group cooperation.

INTEGRATION OF DIFFERENT INTERESTS MANAGEMENT'S TASK

Clearly, the task of management is, and in future, will increasingly be, to integrate the interests of capital, customer, and labor. The treasurer is responsible for the security of capital; the sales manager's task is to discover the customer's needs and to supply them; the personnel manager is charged with the welfare of labor. That the necessity for employee representation in management was so long unappreciated is a commentary on our greedy short-sightedness. Capital found asserting authority over labor easy and concluded that, therefore, it need only issue orders without regard to welfare. Now on the verge of a world-wide struggle for its very life, capital is learning what still remains for labor to learn in its larger meaning; survival value comes from group cooperation.

In integrating interests, management must (*a*) provide conditions, processes, and men to produce goods that the customer wants and must produce them at a reasonable price and (*b*) see that these conditions and processes offer the men a chance to develop and to be happy. These things have not been done in the past because management has been too shortsighted to see that labor needed its interests protected by a personnel manager just as much as capital needed its interests represented by the treasurer. As a result, labor has demanded and obtained a hearing through the coercive action of the unions. Employee representation, entered into with sincerity and never as a technique by which to evade rather than to defy the needs of labor, would have avoided the present unhappy conflict if it had been adopted half a century ago. It is too late now, for more things than civil suits have a statute of limitations, and the time has passed when labor would correctly interpret such cooperative action. When a thing is done by concession, the element of cooperation is already dead.

Labor has been exploited and dominated by capital in times past and, now, it is found that capital is to be exploited and dominated by organized labor—labor that will talk about bargaining but will really operate by the threat of monopoly. Part of capital has been very selfish in the past, but it has, at least, had brains enough not to kill the goose. Labor, with a less enlightened and consequence-perceiving greed than capital,

[1] Prophecy and History," by G. Boas, *The American Scholar*, vol. 5, no. 4, 1936, pp. 431–440.

Presented at a meeting of the Metropolitan Section, New York, N. Y., Nov. 12, 1936, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

will, if it ever should come into power, destroy itself by destroying the sources of its livelihood.

We already have a labor party in politics. In the past, capital has fought organized labor by using the courts, the police, and the militia. Now labor will attempt and probably succeed in dominating capital by legislation. The result will prove a boomerang in the form of lost markets and unemployment. Finally, perhaps in a quarter of a century, the fact will become apparent that, fundamentally, the interests of capital, customer, and labor are all one and the same. Capital wants the mill to run that it may have a return on its investment; customers want the mill to run that they may have goods to satisfy their needs; labor wants the mill to run that it may earn an honest wage. These elements may differ as to how the mill should be run, but that it does run is to the interest of every one of them. The possibility of so-called overproduction is a side issue and not germane to the discussion. The real point is that survival value comes from cooperation.

Differences of opinion as to how the mill should be run are inevitable. We understand situations and interpret facts only in terms of our background, and every one of us has a different background. Furthermore, our very civilization offers maximum opportunity for controversy. The days when Daniel Boone could pull up stakes and move west because someone built a cabin within twenty miles of his are gone forever.

As has been pointed out many times before, controversy is a meaningless adolescent muddle until one has the facts. Unfortunately, to get the facts is hard in so complicated a relationship as modern industry presents. The very fact-gathering process is often an interpretation of facts, as is at once apparent when what are called "the facts" are presented by management and by labor in a strike.

FOUR METHODS OF RECONCILING DIFFERENCES OF OPINION

Since differences of opinion are inevitable, and since the task of management is to perceive, to understand, and to correct these differences, what possible methods are at its disposal? May P. Follett suggests four,[2] of which she approves only the last. These methods are (*a*) voluntary submission, (*b*) domination, (*c*) compromise, and (*d*) interweaving interests.

Voluntary submission means that the situation is deprived of what might have been the contributions of one side. It also means that someone is denied the possibility of developing as he should.

Domination is the old law of the jungle and we love it. Every nursery is acquainted with it, and it is not unknown in high places. True, if you have force at your command, it gets the fastest results. It is the easiest short-run course and does not require much intelligence. But the dismaying fact about it is that no solution by force is ever permanent, and it inevitably leads to ill will and reprisal.

Compromise, like jealousy, promises much and delivers absolutely nothing. I doubt very much whether anyone can cite a compromise, as defined by Webster, which had long-run successful results, because compromise is never anything more than sugar-coated domination. The Missouri Compromise of 1820 was intended to avert the Civil War. It merely postponed and aggravated it. By its very nature, compromise is effected in terms of the relative strength, or ability to dominate, of the two sides, and the relationship is not static. When the situation has changed enough, a fight will result.

Only where an understanding of the needs of both sides and an interweaving of these interests exist can long-run results be obtained. This is difficult because brains and time are required to achieve an effective understanding. I know a woolen mill where the management did not learn for two years that the real cause of their strike was not the desire for shorter hours and more pay, but poor lighting in the weave shed. What a man says he wants and what he really needs are not always one and the same thing. Considerable intelligence is needed to penetrate a situation deeply and accurately enough to give each party what it really needs.

[2] "Creative Experience," by M. P. Follett, Longmans, Green & Co., New York, N. Y., 1930, 322 pp.

THESE FOUR METHODS APPLIED TO A DOMESTIC DIFFICULTY

To illustrate these four methods of solution, suppose a small boy has started in the spring to build a glider in the cellar. It is still incomplete when the chill October days come. A marvel of gossamer frames and spars, it stretches 18 ft across the cellar from the gas meter to the coalbin. Father now needs to get at the coal, and the contortions necessary to do this without interfering with the wing are almost as bad as carving a turkey around a goblet of tomato juice.

By voluntary submission, the boy abandons his project. By domination, he unwillingly removes the precious structure just because Dad says so. "But," he reflects to himself, "when I grow up, Dad will see things differently, or else!" By compromise, Junior can have his glider across the horses from 9 a.m. until 9 p.m. but get it out of there between times. Some day he forgets, or perhaps a glued joint is not properly set by 9 p.m., or, on a cold day, the furnace requires extra attention in mid-afternoon. Possibilities for friction are multiplied by the fact that the solution was a compromise.

What does Junior need? A clear space where he can have his glider rest undisturbed upon the horses. What does Dad need? Unimpeded access to the coalbin. By the interweaving of interests, father and son will cooperate in moving the woodpile to under the cellar stairs, in clearing out the accumulation of boxes in the corner, and in slinging the screens from a cradle under the beams overhead, thus providing another place for the glider which in no way interferes with the coalbin. That this is a simple illustration in no way detracts from the fundamental truth it conveys.

MANAGEMENT A MORE DIFFICULT TASK IN FUTURE

Management of the future will be a more difficult task than the old management has been. This is partly because the unenlightened past has tried to dominate labor, succeeding to some extent but also engendering the spirit of retaliation. It will be more difficult because it can succeed only by the interweaving of interests. It will be doubly difficult because the leadership of labor has gotten outside of its proper place within the triangle and this leadership is not intelligent enough to see long-run consequences. Real brains are soon picked up by management—not by the unions—because labor cannot pay its leaders as capital can.

In the next half century, management will face greater difficulties than ever before. Because psychologists have shown us that there is no such thing as a pure reaction, it is always a reaction to some stimulus, the first step of an enlightened management will be to say, "What must I do to myself to get the right reaction from capital, customers, and labor now and in the future?" To say, "What must I do to labor to get the right reaction?" is clearly domination.

What must I do to myself? How are the needs of all parties concerned to be satisfied by an interweaving of interests? These are the questions which, sincerely and intelligently answered, yield that survival value which comes from group cooperation.

Some day after a long, unnecessary, and disastrous struggle we shall achieve such cooperative action.

The Influence of JAMES HARTNESS[1]

By JOSEPH W. ROE

SOUTHPORT, CONN.

AFTER James Hartness' governorship, the burden of active management of the Jones and Lamson plant was gradually shifted to younger shoulders.

He came and went from the plant, centering his attention chiefly on those things which interested him. He would follow these through and into the shop, and used to talk freely with the older workmen like Marshall, Taylor, and Whitney, who were his lifelong friends. They all knew and felt that he had come up from the ranks, and all speak of him with respect and pride. Their very grousing was affectionate, as when Frank Whitney told Porter that the Governor came into the shop one day and asked him to make some gadget or other, telling him to make a certain depression in a steel block just the shape of his thumb, holding it up to show him. "And then," said Frank, "doggone him, he went away and took his thumb with him."

JAMES HARTNESS

Through all his life there was never a serious break in the friendly relations in his plant. His sense of humor was a bond, although sometimes one could not be sure whether he was censuring or poking fun. He was wholly free from conceit and talked freely of his ups and downs and his own shop experiences. Once he told Porter, "I can't tell you how the loyalty of these men strikes to the bottom of my heart." One of the "old timers" tells how in the days before compensation was on an organized basis, Hartness would come into the paymaster's office and say, "So and so is home sick. Send him his regular envelope until he gets back, and charge it to me." No one else would know about it and the sick man himself had no intimation that it was not a routine company matter. Probably no one will ever know how many kind and generous things he did, not only through these later years, but all through his life. They keep cropping up from the Torrington days on.

One of the older men tells of meeting Hartness on a Sunday walk up on Sunset Hill behind his house, and of their sitting on a stone and having a long talk on religion, an evidence of long friendship, as Hartness did not talk lightly on this subject.

His position in Springfield was unique. He was one of the chief factors in its prosperity, and although he took little or no part in town politics he was its foremost citizen. One of the things to which he contributed is little known—the cooperative work set up between the high school and the machine shops in town. It was initiated by E. R. Fellows and Flanders. Under this system the boys alternate, during their later years in school, between periods in school and in the machine shops, learning the machinist trade. The work in the school and in the shop is coordinated to provide the best training. Nearly 85 per cent of the high school boys in Springfield go into machine shops somewhere, and 61 per cent into the shops in their own town. This is a sidelight on one reason why Jones and Lamson find Springfield a favorable location.

Hartness was never a vigorous man physically. From boyhood he was subject to headaches, and from time to time was kept from work by illness. He was slightly above medium height, slender, and in later life his shoulders stooped a little. His hair became iron gray, but scarcely thinned at all. His keen, alert eyes were, even behind glasses, his most expressive features. They could dance with fun, change with every new thought, settle upon one intently when he listened, or flash if he were aroused.

His mental operations were quick, orderly and incisive, with that most precious blessing, a saving sense of humor. The rapid flashes of insight for meeting a given requirement with some invention might be followed by days when he would say his mind was not working. After a long stretch of high-speed thinking, he might be depressed and wearied. His combination of intuition and capacity for intensive and sustained work was a major element in his success as an inventor. His one political campaign showed that he enjoyed a good fight and fair play.

He was not an omnivorous reader, but he was that rarer thing, a self-starting and persistent student. His pleasures were those of a man of mind, and he was probably more widely known for his avocations than for anything else. His conversation was always worth-while and stimulating. Although he was a heavy earner for most of his life, he was never money mad. He spent freely and generously, but never foolishly or for show.

Hartness was a many-sided man. His position as a tool

[1] From "James Hartness: A Representative of the Machine Age at Its Best," by Joseph W. Roe. THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, 1937. Cloth, 6 × 8¾ in., 160 pp., illus., prepublication price, $3.25.

designer is outstanding. Maudsley, Nasmyth and Spencer created entirely new types of tools. Hartness' great contributions, like those of Sir Joseph Whitworth and William Sellers, lay more in radical improvements of existing types than in the introduction of new ones. His tools were better designed, better built, more accurate, simpler, and had greater power and usefulness than the machines they superseded. He touched nothing he did not improve. His most important invention, the flat turret lathe, was not only a successful machine; it incorporated principles of design of highest value. He was a leader in making high accuracy possible in mass production, and a pioneer in entirely new methods of gaging.

His thinking as a designer was clear and original. He broke free from tradition, but was always guided by wide experience and kept in touch with realities. Following his own advice he never lost sight of the problems of production, or the four human elements inseparably connected with every mechanism; the men who must make it, sell it, buy it, and use it. The engineering profession gave him the highest offices in its gift, and his leadership was as widely recognized in Europe as in his own country.

Hartness was more than a brilliant inventor. He was a successful business man, in the best sense. His associates, workmen and community prospered with him. He sensed from the start the advantages of specialization and standardization and was one of the leaders in putting these principles into practice. He did so with a thoroughness and determination which amazed every one. It was like E. K. Root's adoption of jigs and fixtures at Hartford thirty-five years before. The outcome of his policy, like that of Root, soon silenced all critics. His methods were carried out elsewhere by those trained under him and his example had a wide influence in the whole machinery industry.

His success was honorably earned and the best of it all was that it neither softened him nor hardened him, nor cost him a friendship.

The charge is made, and too often is justified, that the industrial leaders of this country are not interested in public affairs except as they affect their own business. Hartness is free from this criticism. He is a conspicuous example of the engineer in public life. He gave the best years of his life to the service of various professional societies and technical commissions, and to his state as commissioner, administrator, and governor. The almost complete cessation of the stream of inventions during these years indicates how much of his time and strength went into these activities. Like his professional career his public service was disinterested, distinguished, and valuable.

The quality of Hartness' personality comes out in his deep and enduring friendships. Rich and poor, young and old, distinguished people and every-day folk all tell the same story of his quick sympathy, generosity, and understanding. His mind was fascinating and stimulating, opening out in unexpected directions. He was a marvelous man to work for. His thinking was clear as crystal, his methods out in the open, his standards for himself and all about him high, and his faith in what he was doing infectious. The records of those who worked with and under him show his influence. But that influence was not confined to the successful. All felt it.

To those who knew James Hartness intimately, the man himself was finer than anything he had or did.

We have many earnest reformers—Gandhi is one—who deplore the machine as the root of all evil, and decry the machine age and all its minions. They long for the good old handicraft days, when all workers were artisans, took creative joy in labor, and men were happy. To these the inventor is a public enemy, and the machine a monster, with deadening habit and division of labor as its evil progeny. It is hard to reason with them, they are so convinced.

But to the open-minded, the life of James Hartness is illuminating. Here is a man who grew up in a machine shop, acquired such training as he had in its atmosphere, was a prolific inventor of machinery himself, and head of a great tool-building industry. He made every possible use of machinery in his own plant and sought to extend its use in others. He believed in habit and division of labor and utilized them as far as possible. Instead of looking on habit as a curse he welcomed it as relieving the mind from attention to routine and freeing it for more creative things. From point of view and from lifelong practice he was a machine-age man. What effect had this on his own life and on those about him?

Mrs. Dorothy Canfield Fisher knew Hartness well. She refers to him when she makes one of her characters in her novel "Rough Hewn" say: "I used to make my living buying and selling lumber in the New England states. . . . On one of my trips I met a man in a narrow mountain valley up there who was a creator if there ever was one. He had started life as a mechanic, left school and went to work at sixteen, in a shop filled with soulless cogs and bolts and screws and springs. And his creative instinct rose up and seized on those things as the appointed raw stuff for his creations. When I saw him he was the head of one of the biggest metal-working factories in the country, a good many hundred men working for him, and devoted to him, turning out tools that have simplified the tasks of mechanics the world around. I never saw a happier man. I never saw a life more completely fulfilled. Today, walking on the Due Macelli, I happened to see a case of his tools, and outside just glued to the window, a young Italian mechanic gazing in at them, his face on fire with admiration and appreciation. Quite a long way for a Yankee creator to reach out a helpful and stimulating hand! But he was a first-rater, of course, a genius. The rest of us can't hope to do that."

Though trained at a workbench and tending machines, Hartness had a more ranging mind than most university graduates. Instead of having his soul hardened by contact with the machine, all his relationships were conspicuously human. His workmen, instead of becoming robots, built and used telescopes. Because of the skill with which he devised machines and the spirit in which he used them, they had a better livelihood and better minds than they might if they had had only the crude hand tools used in colonial days. The whole community was more prosperous and had a higher standard of living.

When one contrasts the dreary picture of the Machine Age of the reformers with the life and atmosphere around this man, the question arises: Are not the reformers confusing abuse of machinery by stupid and cunning men with evils which they believe inherent in machinery itself? Even they would give the old craftsman a better and keener tool with which he might turn out better work. And are not improved machines really better tools with which modern craftsmen, from machine tender to industrial leader, may create not only better goods and services, but a higher social life for all? The real evils in the modern industrial system lie not in the use of machines but in their misuse. As Dean Kimball has said, machinery and improved manufacturing methods make possible a higher standard of physical, social, and moral life, but they by no means insure it. The spirit with which they are utilized determines whether or not they are a blessing.

In the hands of such men as James Hartness they become a benefit to all. His life represents the spirit of the Machine Age at its best.

LABOR PROBLEMS

By W. RUPERT MACLAURIN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HERMAN FELDMAN, professor of industrial relations at Dartmouth College, has recently published a case book of labor problems.[1] In a foreword Professor Feldman explains his objectives: "The problem method is particularly needed in the teaching of labor relations. One of the troubles in this field is that too much is taught in terms of generalities of economic and social principles, irresponsibly or sentimentally applied, and that too little is considered with reference to the ways in which human nature expresses itself in actual situations..... The cases are in the main actual situations drawn from experience. In some of these problems the author has participated personally as consultant or investigator. Others were obtained by plant visits, field observation, and other contacts with industrial and governmental employment."

Teachers of labor problems should welcome this book. It should also be of significance to the general reader interested in studying labor problems. Professor Feldman explains that the cases should be supplemented by reference to a general textbook or to specific studies on some of the problems presented. The problems are intended to raise questions in the reader's mind rather than answer them for him. Herein lies their principal value. The teacher of labor relations who has had to rely in the past on a textbook, has been handicapped by the fact that the textbooks do not effectively present issues on which the student must reach a decision. The average college student in the United States today taking an introductory course in labor problems, while ignorant of the background of the labor movement, frequently has preconceived notions about trade unionism, collective bargaining, and the rights of the employer. It is therefore much more difficult in a course on labor to induce the student to view labor problems in an objective fashion than it is in such courses as banking, corporation finance, or international trade.

Most textbooks in the labor field are written from a definite point of view. Whether the point of view in question is right or not, the fact that the conclusions are stated in a declaratory manner leads the student to reject or accept them without thinking the problem through for himself. For this reason a case book in the field of labor relations is particularly welcome.

THE CASE METHOD OF INSTRUCTION

However, the case method of instruction has certain weaknesses. For example, it is often difficult to give the student sufficient background material in cases to enable him to reach a decision on the issue raised. To do so may involve writing very long cases. Thus most of the cases which have been used in the past in the course on labor at the Harvard Business School have been from 20 to 40 pages long. Such cases are useful pedagogically in forcing the student to do what he will have to do in actual business, that is, dig out the issue and reach the solution of a problem from a lot of extraneous material. But in a short introductory course the extensive use of long cases leaves the student little time for more general reading in the labor field. Moreover, a course taught entirely by the case system tends to lack continuity. While it may leave the student with a collection of principles implanted much more vividly than would have been achieved by the exclusive use of a text, these principles are frequently unrelated in the student's mind and leave him confused in his attitude toward the broader aspects of the subject which have only been treated in a piecemeal fashion.

There is much to be said, therefore, for a case book such as Professor Feldman has written, which frankly leans on a textbook for background but which encourages the reader to form his own opinions on the basis of the cases which are presented rather than accept the opinion of the author of the textbook.

Feldman's cases are short, perhaps too short. They range in length from half a dozen lines to three pages. They contain almost no background material but merely the statement of an issue. Sometimes only one side of a problem is presented and sometimes both sides. The cases are grouped into 70 "problems," four or five cases to a problem. The problems in turn are arranged under five main headings: Wages, wage methods, and wage administration; hours, working conditions, and labor regulations; insecurity and unemployment; the personal environment; and group relationships and unions.

The effort of the author to be objective is well sustained. Thus there are cases on labor racketeering and the irresponsibility of some unions as well as cases of successful union-management cooperation.

HARD QUESTIONS FOR INDUSTRIAL UNIONISTS

Almost all the problems are of current interest and many of them bring out arguments which are not frequently encountered in public discussions of the issue. Let me illustrate by quoting in part from problem 61, which is entitled, "Some Hard Questions for Industrial Unionists." This problem, according to the introductory statement, "frankly takes the form of presenting only the practical objections and difficulties asserted by craft unionists. It is expected that this challenge to keener thinking on the part of industrial unionists will have the result of assuring a more realistic and mature understanding of the structural readjustments in unionism required, without necessarily gainsaying the place or superiority of industrial unionism."

Case *A* explains that in a tobacco plant "the spokesman for the machinists' union argues that the machinists are a separate craft by occupation, payroll classification, and supervision, and that it is absurd to have a wholly different union as guardian for men in a highly skilled craft. He states that whatever might be the possibilities of an industrial union in a metal-working plant, there is no basis whatever for such unionism where the nature of the work of the great majority of the workers is tobacco manufacture."

Case *B* considers the position of a group of electrical workers whom the brewery workers' union—an industrial union—claims as members. "The local agent of the electrical-workers'

[1] "Problems in Labor Relations," by Herman Feldman: The Macmillan Co., New York, 1937.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

union points out that an electrical worker, unlike a brewery worker, is employed in various industries. Should the electrical worker want to go into the building trades or into other plants, he would find himself limited by the fact that he is a member of the brewery-workers' rather than the electrical-workers' union."

Case *C* is entitled "'Wage Chaos' for Craft Workers." "The Carpenters' Union states that at present it is able to establish standard wage scales in communities or areas, whereas if the competitors were members of industrial unions every union might permit a different scale for competitors in the agreements. Thus one doing the same work might receive $8 a day in an automobile factory, $9 a day in a rubber factory, and $10 in a brewery. It is also stated that officers of vertical unions will never be intimately familiar with the craft conditions of employment and methods of production in other establishments. The result will be a multiplicity of wage scales which will unsettle the market and cause trouble."

Case *D* raises the issue as to the stability of industrial unions. Are the unskilled workers, once organized, likely to be able to hold their organization together in a period of crisis as the strong craft unions have done? History, it is asserted, indicates that they will not be able to do so.

Case *I* is entitled "'Martyrdom' Required of Skilled Workers." "The union official of a highly skilled group of workers in the railroad industry states that these men are in a particularly favorable position to bargain with their employers because, although they constitute only about one tenth of the workers in the industry, if they go on strike, trains cannot run. They have a strong union organization and are satisfied with the terms and conditions which their contract specifies. They say, therefore, that for them to become part of an industrial union would be to sacrifice their technical position in behalf of workers who have not taken pains to acquire a skilled occupation and who have not been loyal enough to unionism to stand by their organization during periods of sporadic leadership."

Case *F*. "Fear of Unmanageable Size of Industrial Unions." "A union officer in the building trades opposed to industrial unions states that if they combined their workers into one big union they would probably enroll a million workers. This, he states, would put the top official way out of the reach of the other workers and would create much the same kind of problems as overexpansion and excessive size in our large corporations. Unions and officers 'would lose the personal touch and the intimate knowledge of particular group conditions which are so valuable a part of craft unions.'"

Case *G*. "Prophesy of Internal Struggles." "A craft union protagonist points out that 'when you put together a lot of miscellaneous crafts into one union, there will be clashes of interest and opinion leading to internal struggles, secession, unsanctioned strikes and other consequences, with the possible result also of making it impossible for an industrial union to maintain its contract.' He also asserts that the United Mine Workers, as an example, has had a continuous series of difficulties with rival and insurgent groups. He further draws attention to the fact that 'The International Typographical Union at one time had under its jurisdiction and as part of the organization the compositors, proofreaders, pressmen, bookbinders, stereotypers and electrotypers, mailers, news writers, photoengravers. By agreement the bookbinders, stereotypers and electrotypers, and photoengravers have formed separate organizations from the International Typographical Union.'"

The problem ends with the question: "In what way can the structure of craft and industrial unions take into account the obstacles mentioned and adjust the forms of unionism to meet the difficulties?"

The case book concludes with a carefully selected reading list arranged according to the topics covered in the book, with a brief comment on the contents of each book.

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ACTIVITIES *and* PROBLEMS *of the* AMERICAN ENGINEERING COUNCIL

By A. A. POTTER

PRESIDENT, AMERICAN ENGINEERING COUNCIL

INTEREST in cooperation among different engineering groups and the need for an agency to provide, on behalf of our profession, tangible service to public agencies, prompted, in 1920, the organization of the American Engineering Council with Herbert Hoover, then Secretary of Commerce, as its first president. From its very beginning it has been an organization of organizations intended to aid the engineering profession in presenting a united front in matters of interest to our government and to the public. While the Founder and other major engineering societies have been aiding in professional development of the engineer, the American Engineering Council has been supplementing their efforts by relating the engineering profession to public welfare and by making our government, as well as the public at large, conscious of the value of the engineers' services and contributions. It has served during the past 16 years as a clearing house for questions of public nature which require technological knowledge and engineering experience, and it has acted as an advisory body for the various engineering societies in connection with problems of government. At the same time the American Engineering Council has been an agency of inquiry into economic and social problems as affected by technology.

THE FOUR MAJOR FUNCTIONS OF THE A.E.C.

The major functions of the American Engineering Council are performed through four groups of committees, which are concerned with public affairs, engineering economics, operations within the Council and united action of its member societies. These committees, through 17 subcommittees, are in close contact with trends in the conservation and utilization of our national resources, relation of the engineer in private practice to government, patent legislation, public works, aeronautics, surveys and maps, rural electrification, merit system in public service, inquiries in the fields of social and economic activities of our country, and similar problems in which engineers may have opportunities for coordinated action.

The problems of the American Engineering Council have taken a new slant since 1934. Instead of the normal process of legislation on engineering matters, the A.E.C. has had to work during the past three years with a group of administrative departments, whose legislative authority and funds had been established by administrative order. Government departments and bureaus had to be "reeducated" about the American Engineering Council, and its work had to be changed from an orderly process of committee reports and committee hearings and procedures to the specific acts of keeping up with rapidly changing conditions.

Much of the work of the American Engineering Council had to go unreported because it had to do with contacts and associations with individuals in the government, and one of its main tasks had been to make and keep friends with the constantly changing and greatly expanding agencies of the government. Much of the work had to be confidential and some intangible, but a few of the high points may be discussed.

The American Engineering Council has had a constant demand for engineers from government agencies and a large portion of the time of the staff had to be devoted to employment problems for the government bureaus and departments. This service included not only the recommendation of engineers to the various government agencies but also aid to administrative agencies in planning the handling of such work as emergency mapping under the WPA, Rural Electrification Administration programs, Rural Resettlement plans, and NRA codes.

The American Engineering Council is constantly being consulted as to salaries to be paid to engineers and is guided in such requests by the reports of the Founder member societies. It is also invited to suggest names of consultants for various enterprises.

The American Engineering Council has been instrumental in placing numerous engineers in important consulting and line engineering governmental positions, those appointed to such positions seldom knowing the part that the A.E.C. has played in placing them, as it has always been careful to submit a number of names and not to promote the employment of any particular individual.

As part of this employment service, the American Engineering Council had attempted also to analyze and to make a survey of the employment of engineers by government, classified by divisions. Government bureau chiefs are fully appreciative of this service and realize that advice and recommendations by the American Engineering Council are based solely upon the ability and technical competence of engineers and not on questions of political preferment.

During the past few weeks, at a request of one of the national member societies, the American Engineering Council made an exhaustive examination of those laws, regulations, interpretations, and procedures affecting the engagement of technical talent and engineering service by the federal government outside of the civil service. Conditions in more than thirty of the principal agencies known to be using technical talent were investigated, and the results, when finally compiled, should prove of great value to the engineering profession.

A.E.C. ADVICE ON QUESTIONS OF POLICY

The American Engineering Council has been called for service in connection with matters of policy affecting emergency government setups. A concrete illustration is its relation to the National Resources Committee. Immediately after this committee was set up, as the National Resources Board, the executive secretary made contact with its chairman and director. This was followed by a conference with the chairman, arranged by the American Engineering Council, at which were present the secretaries of the member national societies and from which grew out contacts which closely related engineers to the work of this Committee.

Many of the earlier reports of the American Engineering

A report to the Council of The American Society of Mechanical Engineers, read at its Semi-Annual Meeting, Detroit, Mich., May 17, 1937.

Council on such questions as flood control and the policies for the development of water resources were transmitted to the National Resources Committee and the recommendation of this new agency of government has reflected, in part at least, the recommendations of the member organizations of the American Engineering Council and of its committees. Specifically, the proposal for improvement in collecting water-resources data and the whole question of the development of water resources on the basis of conception of the "water shed," rather than on the basis of states alone, were in the earlier reports of the American Engineering Council.

The authors of the number of reports issued by the National Resources Committee were recommended by the American Engineering Council. Even the most recent report, now in press, "Technological Trends and Their Social Implications," has been influenced by advice from the American Engineering Council.

AID GIVEN IN MAPPING AND SURVEYING

This is a matter which is having the active interest of the American Engineering Council and has been helpful in educating the Budget Bureau on the value of an adequate mapping program. The American Engineering Council has worked with the Federal Bureau of Surveys and Maps in rounding up the opinions of organizations with reference to this program. Its aid to individual states has resulted in definite progress. A concrete example is Indiana which has appropriated a considerable sum at the 1937 session of its legislature for mapping.

VARIOUS INTERESTS CONDUCTED

The Upstream Engineering Conference, the Third World Power Conference, and the plans for the World Management Conference are examples of activities by the American Engineering Council in the interest of united action.

CENSUS OF ENGINEERS SUGGESTED

The American Engineering Council, through a committee of which a secretary of a Founder society was chairman, was instrumental in this study by the Bureau of Labor Statistics of the United States Department of Labor. This study made available data regarding 60,000 engineers with reference to such questions as employment conditions, compensation, and distribution in different fields.

ENGINEERING ECONOMICS GIVEN THOROUGH STUDY

The activities of the American Engineering Council in studies in engineering economics have been helpful in projecting the engineering profession into the fields of thinking and action relating to our national social, economic, and industrial questions. Among the early contributions of the Council in this field may be mentioned the reports on "Waste in Industry," which had a profound effect upon the conduct of industry the world over; the "Twelve-Hour Shift in Industry" (1921), which demonstrated the merits of the shorter working day; "Civil Aviation" (1924), which focused the national point of view upon the development of commercial aviation; "Radio Broadcasting," which was instrumental in bringing about present policies and practices; and "Water Resources," which was helpful in appropriations for the installation of the national hydraulic laboratory.

Among the recent engineering economic studies of major value may be mentioned the inquiry of the balancing of forces which has greatly influenced economic thought and action during recent years.

There is need for accurate knowledge to show the real effect of science and technology upon social security; such information should go a long way in overcoming the present tendency to make the engineer the major scapegoat of our social ills, by showing that engineers create employment, wealth, comfort, values, and other factors which definitely contribute to social security. The American Engineering Council is now endeavor to ally itself with representative economists, sociologists, and statisticians in order to study questions of this type and to guide in the public interest some of the questions of larger policy which lie in the fields of both engineering and economics.

There is also need for factual reports, for the benefit of the public, by committees of leading engineers on the engineering projects of our government. Engineers have an opportunity to show, through nonpartisan and unbiased services, their competency and integrity, and to make the public more conscious of engineering contributions. The American Engineering Council hopes that before long it will be in a position to finance the preparation and distribution of more reports, on behalf of our profession, which bear upon public welfare.

A.E.C. IS CONCERNED WITH NATIONAL PROBLEMS

The American Engineering Council is concerned with national questions to which engineers may contribute cooperatively and in problems in which the engineering societies may have opportunity for coordinated action. It is not a super organization intended to manage or to interfere with the autonomy or with the specialized fields of its member societies. It is striving to serve the public and to bring about a better appreciation on the part of all, and particularly of government agencies, of the importance and value of the engineer's contributions. It is endeavoring to bring about concerted action on the part of engineers in public questions of national scope, and a definite interest on the part of the engineering profession in a well-balanced social structure and good government. By representing the engineering profession in matters of public welfare, government, and of joint interest to all engineering societies, the American Engineering Council serves the engineer and the public.

Changing Demands on Technical Graduates

MOST INDUSTRIES dealing with technical products and processes are witnessing some fundamental changes. These create new demands upon the technical graduate, and the indications are that they will be more pronounced as time passes. . . . Technical skill, in past years, has been largely devoted to invention, design, construction, and operation as related to technical products. We have devised remarkably ingenious equipment which has been combined with cleverly engineered manufacturing process. We have learned well how to design and operate machinery and equipment with a high productive value and a low production cost. . . . Fifteen or twenty years ago, many leaders of companies engaged in production and distribution of technical products were distinctly technical men. Today, most of these organizations are guided by engineers who have applied engineering methods to commercial situations. Although technically trained, success has come largely through their ability to understand customers and markets and how best to serve them economically and well. Each year, a larger number of technical graduates become thrown into closer contact with problems relating to markets and methods of distribution. These problems call for knowledge and training in the fundamentals of distribution as related to technical products.—*The Journal of Engineering Education*, January, 1937, pp. 422–425.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While no quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

In Event of War

THE BROWN BOVERI REVIEW

THREAT of aerial attack in time of war has made it wise for industrialists abroad to protect their power stations by means of roofs designed to resist such attacks. In the *Brown Boveri Review* for January-February, 1937, drawings are shown of a proposed bombproof Velox power station designed to produce 20,000 kw.

The station is built in a tunnel let into a rock hillside adjacent to an industrial plant so situated as to be vulnerable in case of war. The tunnel section is equivalent to that of a double-track railway tunnel, and contains, in addition to the power-generating and switching machinery, sufficient fuel to last for a week. Where a rock hillside is not available such plants may be covered by massive concrete arches. The compactness of the Velox plant is said to make it particularly advantageous for this service, as the enclosing structure can be of minimum size and thus present an unfavorable target.

Ideas

JOURNAL OF ADULT EDUCATION

IDEAS, says Charles A. Beard in the April, 1937, issue of the *Journal of Adult Education*, are powerful things. They may be divided for convenience into two broad classes: Ideas that represent facts, and ideas that express hopes, ideals, and opinions that are not easily checked against cold facts. The work of educating one's self, he continues, includes the increase of knowledge and the exploration of opinions. If we wish to increase knowledge and diminish delusions, he points out, we should look for interests wherever we encounter ideas and look for ideas wherever we encounter interests. He then offers two suggestions as to how to make a beginning at this kind of education.

First, he recommends, take up a book on some subject with which you have more than casual familiarity. Sharpen two pencils, one black and the other red. Underline in black each sentence or word that expresses a fact that you know to be a fact or can verify as such. Underline in red each word or sentence that expresses a mere opinion as to the desirability or undesirability of the matter in hand. When you have finished look it all over. Then do the same thing with the works of three or four writers who are pretending to inform the public on current affairs. Two benefits will result. You will sharpen your wits for reading and for the quest for truth. You will have some basis for discrimination among those pretending to instruct you. Surely the process is educative and the outcome is educational.

Second, he continues, make a special exploration of fifty or a hundred words commonly used in the discussion of human affairs. Ideas, whether as knowledge or opinion, are expressed in words. Most of us use words without much exploration of them, especially as we render opinions of which we are surest. Even those who imagine themselves educated will be jarred severely if they select a few words in common usage, such as interest, progress, economics, and politics, and look them up in a big dictionary—the bigger the better. Anyone who has done this a few times will never be content with a little dictionary and he will find his powers of critical insight and accurate expression strangely enlarged. The experiment is both informing and exhilarating.

Training of Apprentices

ENGINEERING

GENERAL observations concluding an address by A. P. M. Fleming before the Institution of Mechanical Engineers on Feb. 26, 1937, are reported in *Engineering* for March 19, 1937, and while they refer to British workshop practice they are of general interest to employers everywhere. Mr. Fleming summarizes his observations as follows:

A large amount of evidence shows that systematic workshop training is a more important factor than inherited manipulative skill in determining the efficiency of a craftsman.

Consideration of the effects which the introduction of modern tools and machinery and superior technical processes have had on workshop practice suggests the need during the training of trade apprentices for the development of a greater degree of adaptability and mechanical instinct than was perhaps necessary before these facilities existed.

Alteration of the character of the work required of craftsmen and of the responsibilities devolving on foreman renders it impossible for these men to play the same part in the training of apprentices as in the past.

It would seem desirable that in every firm however small it should be the duty of some responsible officer to undertake the work of selecting the apprentices and of organizing an appropriate scheme of practical training.

The apprentices should be encouraged to attend part-time evening courses at technical schools and, wherever possible, these courses should be supplemented by works instruction bearing more directly on the manual processes with which the boys are called upon to deal.

Increased attention should be given to the provision of facilities for physical training and to stimulating, to the point of active participation, the interest of apprentices in subjects of a cultural nature.

The question as to whether the conventional period of training, which in Great Britain ends at 21, should be changed to a

specific number of years, as in German practice, irrespective of the age of starting, is a debatable one. Mr. Fleming is of the opinion that while a satisfactory knowledge of the technique of shop processes can possibly be acquired in a highly organized four-year course, the youth of 18 years of age is not sufficiently ripe in general shop experience to undertake the full responsibilities of craftsmanship. On the other hand, if for some reason the starting age has been deferred to, say, 17 or 18 years, this shorter intensive period of training should be found to be sufficient.

The provision of adequate facilities for the promotion of superior trade apprentices is an essential requirement for a healthy industrial organization, but in many organizations it is not yet clear how best to maintain an appeal of craftsmanship as a lifework and insure adequate retention in the shop of the highest-grade workers.

The Traffic Problem

THE SCIENTIFIC MONTHLY

IN THE fifteen years preceding 1935, says Dr. Lowell S. Selling, director of the Psychopathic Clinic, Recorder's Court, Detroit, in the June, 1937, issue of *The Scientific Monthly*, more people were killed by automobiles than have been killed in all the wars of the Republic. The problem, he continues, is very definitely one belonging to psychology, because automobiles, properly handled, are fairly safe machines. In the various statistics that have been gathered about accidents, car failure has been found to play a very minor rôle, and if the accident is due to some mechanical defect in the vehicle, that defect is often contributed to by the driver.

In 1928 a judge of the Recorder's Court in Detroit requested that a special study be made of one hundred traffic offenders. Findings tabulated by the Psychopathic Clinic at that time indicated a preponderance of feeblemindedness, and gave rise to agitation that the feebleminded should be removed from the highways. This was in spite of the fact that a number of other observers had found cases of bright persons whose records on the highway and whose mechanical ability to handle a car were inferior to those of individuals who have only border-line intelligence.

Dr. Selling states that several hundred cases have passed through the Detroit clinic and findings seem to be opposed in some respects to those which might have been predicted by the public as exemplified by members of "safety committees," police officers, and others not trained in psychology. He then discusses the points of view of laymen and psychologists with respect to braking time, and shows that a person should drive at a sufficiently slow speed so that the engineering problem of stopping a car will not be of significance. Furthermore, he says, reaction time is not of much importance, for, he continues, more important than the actual ability to respond quickly is the ability to spot the elements of an impending accident long before it is necessary to step on the brake sharply.

It has been found of interest in the clinic, however, to measure reaction time in order to look further for some disease, as long reaction times have been noted in persons suffering from paresis due to syphilis, paralysis of certain muscles, and stupidity almost at the imbecile level.

Vision is next discussed by Dr. Selling, and as a result of the clinic's investigations greater doubt has been raised about where to draw the line with regard to its effect on a man's ability to drive. The usual vision tests given children who show eye weakness have only a questionable place in tests for driving ability. Defective ability to estimate the relative positions of distant objects is important but seldom occurs, even in accident-prone persons. Only in one case in several hundred has the clinic found a color-blind man blind to traffic lights and he was feebleminded. Also with respect to persons with "gun barrel" vision, i.e., narrow range of vision, the clinic would predict that one in two or three thousand would have a diminution of vision of this sort.

The crux of the matter, says Dr. Selling, seems to lie in the measurement of the subject's attitude toward law enforcement and toward the rights of others. If he is anxious to do well he will keep out of trouble as far as possible; and if he is not easily excitable, he should be able to compensate for his visual defects and body structure.

Dr. Selling summarizes the results of the clinic's findings and of its research into the literature by saying that mechanical tests of a driver's ability are of value but are sadly misunderstood, that a complete understanding of the nature and of the make-up of the individual, his attitude as well as his physical structure, is probably of much more value in enabling prediction of proneness to accidents than his ability to react promptly and to make good judgments, that can be measured by machines.

Road to Progress

ELECTRICAL ENGINEERING

CONCLUDING a stimulating, clearly reasoned, and excellently illustrated Steinmetz Memorial Lecture before the Schenectady Section of the American Institute of Electrical Engineers, April 6, 1937, published in full in the May, 1937, issue of *Electrical Engineering*, Harold G. Moulton, president, The Brookings Institution, directed attention to the road to progress. Said Dr. Moulton:

There must be constantly increasing efficiency in production on the part of both labor and capital. Only by everlastingly improving technical processes and lowering the costs of production can we obtain progressively higher standards of living. To try to accomplish this result in any other way means simply tugging in vain at our collective bootstraps.

As efficiency is increased, the benefits must be broadly disseminated among the masses by means of high wages, low prices, or a combination thereof. This is essential for a double reason:

First, it is a fundamental requirement for social and political stability and the well-rounded growth of a democracy. It is doubtful indeed if any economic or political system can permanently maintain itself unless it does maintain the goal of the greatest good for the greatest number.

Second, a broad dissemination of the benefits of technical progress is necessary to provide the market demands for an expanding industry. Under our capitalistic system we produce to sell goods in the market. If we increase capacity to produce without correspondingly increasing the capacity of the masses to purchase, we simply reach an impasse. Production schedules have to be restrained, with an accompanying retardation of the rate of economic progress.

Industrial growth, development, and progress require the expansion of consuming power step by step with the expansion of producing power. To put the matter in the simplest possible terms: Growth in the economic organism like growth in any other organism must proceed from the deepest and broadest possible rootage. It must rest on the expanding well-being of the entire population.

Fuel Spray and Flame Formation

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

FUEL SPRAY and flame formation in a compression-ignition engine employing air flow were studied at the Langley Memorial Aeronautical Laboratory by the National Advisory Committee for Aeronautics and the results of tests have been presented by A. M. Rothrock and C. D. Waldron in Report No. 588, 1937.

The process was studied by examining high-speed motion pictures taken at the rate of 2200 frames a second. A flat-disk combustion chamber was used and air flow was produced by a rectangular displacer mounted on the top of the piston. The

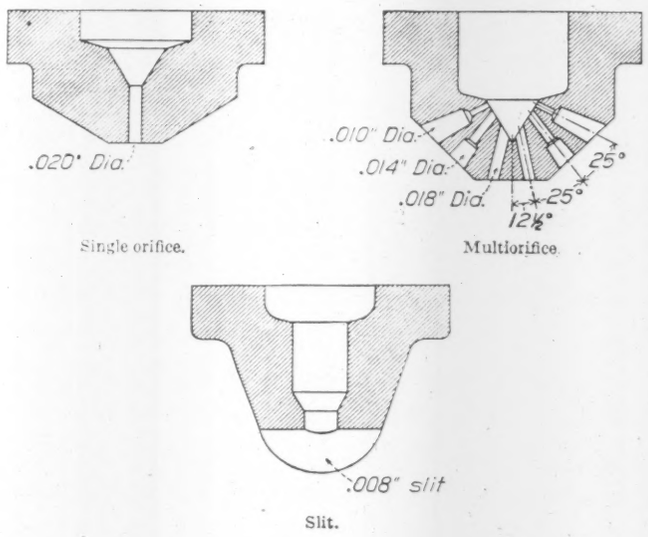


FIG. 1 NOZZLES TESTED

in the index of refraction of a part of the medium between the lenses resulted in light or dark areas being formed on the motion-picture film in the image of the combustion chamber. Because any air movement in the combustion chamber is accompanied by local changes in the index of refraction of the air, the air movement showed up as light and dark streaks in the image recorded on the photographic film. The image of the fuel-spray silhouette and of the combustion was photographed on the film in the usual manner.

Strips of film showing conditions obtaining in the various tests are reproduced in the report with comment on them.

The analysis of the data on the effect of air flow on fuel spray and flame formation has led to the following conclusions:

1 In the combustion chamber of the compression-ignition engine, air velocities as high as 400 fps were not sufficient to destroy the core of a fuel spray from a single round-hole orifice.

2 Air velocities of 400 fps were sufficient to change materially the direction and distance of the spray-core penetration and to blow aside the envelopes of sprays from a single round-hole orifice.

3 As the air-fuel ratio was increased the effect of the air flow on the fuel sprays was increased.

4 With fuel-injection nozzles giving poor fuel distribution within the combustion chamber, air flow increased the volume in the combustion chamber reached by flame.

5 With a fuel-injection nozzle giving good distribution, air flow did not result in much change in the spread of the flame although engine tests showed a large increase in performance.

6 High-distribution nozzles such as the slit nozzle did not show much more effect from air flow than did the sprays from round-hole orifices.

7 High-distribution nozzles damped the air flow considerably.

8 When air flow is employed in a combustion chamber, care should be taken that the motion of the air set up during the induction period is not such as to oppose the desired air flow produced at the end of the compression stroke.

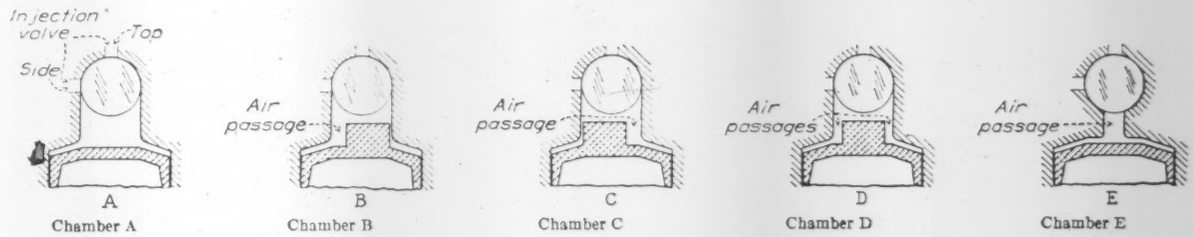


FIG. 2 COMBUSTION-CHAMBER SHAPES TESTED

shapes tested are shown in Fig. 2. Three fuel-injection nozzles were tested in the experiments reported, characteristics of which are shown in Fig. 1.

The air movement, the fuel injection, and the flame spread were photographed through the $2^1/_2$-in. diameter glass windows forming the sides of the flat-disk combustion chamber. A 750-watt projection lamp was placed behind the slit which was placed at the focus of the first lens so that parallel light was transmitted through the combustion chamber to the second lens. A knife-edge was located at the image of the slit and in such a position that two thirds of the slit image was intercepted by the knife-edge. The image of the combustion chamber was focused on the motion-picture film. Any local change in the index of refraction of the medium between the two lenses caused a deflection in the parallel light rays. This deflection caused the light rays to strike either below or above the original point in the image of the slit. Therefore, a change

CO in Engine Exhaust

INDUSTRIAL AND ENGINEERING CHEMISTRY

INVESTIGATIONS of the relative amounts of carbon monoxide in the exhaust from internal-combustion engines using gasoline, and 10 and 20 per cent ethyl-alcohol-gasoline mixtures, reported by L. C. Lichty and C. W. Phelps in the May, 1937, issue of *Industrial and Engineering Chemistry*, showed that the air-fuel ratio is the important factor in all cases. This relation between the exhaust products and the air-fuel ratio was shown to be practically constant for both gasoline and the alcohol blends, except that the values for alcohol blends occurred at lower air-fuel ratios because of the different air requirements for combustion.

At maximum-power air-fuel ratios for both gasoline and alcohol blends the carbon monoxide present in exhaust gases

was found to be about 2.7 and 3.8 per cent for single- and multi-cylinder engines, respectively. When more than the amount of air theoretically required for combustion was used and good mixture distribution was assured, no appreciable amount of carbon monoxide was found in the exhaust. However, when carbon monoxide was eliminated by the use of lean mixtures, obtained either by restricting the fuel flow or by substituting a fuel such as an alcohol-gasoline blend, an appreciable loss of power resulted; this loss averaged 6 per cent for all the fuels tested, based on wide-open throttle.

The authors conclude that the substitution of alcohol-gasoline blends for gasoline would not eliminate or sensibly reduce the health hazard due to carbon monoxide in the exhaust of internal-combustion engines.

Compressed-Gas Filling Stations

DEMAG NEWS

ONE effect of a policy of economic self-sufficiency in a country lacking petroleum supplies is found in the abatement, in Germany, of taxes on all vehicles driven with home-produced fuels.

According to the *Demag News* for March, 1937, so many automobiles have been changed over to operate on compressed town gas that filling stations have been erected so that in certain localities long-distance traffic dependent on such fuels can be maintained.

The compressed-gas filling station consists of a compressor and storage bottles housed within the station and metering devices outside by means of which the gas is transferred to the tanks of the customers' cars. Fuel-gas propulsion with highly compressed town or methane gas is said to have won acceptance on grounds of economy and technical advantages, such as, easier starting in cold weather, odorless and sootless operation, reduced cost of engine upkeep, and freedom from crankcase dilution of lubricating oil. Reduction in vehicle tax made it possible to absorb some of the expense of converting vehicles to the use of the compressed-gas fuel.

After successful preliminary tests the Berlin Transport Company began, on Jan. 20, 1937, to convert 19 busses covering an operating distance of 2460 miles daily to lighting-gas propulsion. The erection of compressed-gas filling stations has been a necessary consequence of the introduction of the new fuel for commercial use.

Domestic Stokers

ANTHRACITE COALS, INC.

FROM 1931 to 1936 the sales of domestic stokers in the United States increased from 2500 to 73,376, said R. E. Howe, in an address delivered on May 11, 1937, at the Coal Conference, Raleigh, N. C., sponsored by the School of Engineering and College Extension Division, North Carolina College of Agriculture and Engineering, assisted by the North Carolina Retail Coal Merchants Association. In 1937, Mr. Howe predicted, 110,000 domestic stokers would be sold. Mr. Howe said that the demand for stokers would extend further into the lower-income brackets, and, as stoker manufacturers were getting into mass production, the time was not far distant when any home owner who could afford a furnace could also afford a stoker.

Steam-Tables Research

JOURNAL OF RESEARCH

REPORTS from the three laboratories, and from commentators on other work, that shared in the research project on the thermal properties of steam undertaken in 1921 by The American Society of Mechanical Engineers were, for many years, featured in MECHANICAL ENGINEERING. Out of these researches and the International Steam Tables Conferences which brought together workers from all over the world grew the Keenan steam tables published by The American Society of Mechanical Engineers in 1930, and the new Keenan and Keyes tables reviewed by R. C. H. Heck in MECHANICAL ENGINEERING for February, 1937.

There has recently appeared in the *Journal of Research* of the National Bureau of Standards for April, 1937, Research Paper RP983 of the National Bureau of Standards, entitled "Calorimetric Determination of the Thermodynamic Properties of Saturated Water in Both the Liquid and Gaseous States From 100 to 374 C," by N. S. Osborne, H. F. Stimson, and D. C. Ginnings. The report describes the experimental apparatus and methods used, the results of the measurements recorded, and the manner in which the adjusted experimental data were assembled, combined, and tabulated in terms of the specific values usually compiled in steam tables. Tables of data and of the properties of steam complete the paper.

Although the paper is too long and contains too much detail for satisfactory condensation, a résumé of the theory of the method by which the experimentally measured quantities, α, β, and γ are related to the familiar thermal properties may prove helpful.

The experimental determinations of heat capacity of a sample of water gives as a result the increase in the quantity α

$$H - Lu/(u' - u)$$

over the observed range of temperature, in which H and L denote, respectively, in energy units, the enthalpy of saturated liquid and heat of vaporization per unit mass, and u and u' denote specific volume of saturated liquid and vapor, respectively.

In latent-heat experiments there was measured the energy added when water was evaporated and withdrawn as saturated vapor at constant temperature. This amount of energy per unit mass is equal to $L + Lu(u' - u)$, for which the symbol γ is used. The ratio $u(u' - u)$ is the fraction of a unit mass evaporated but remaining within the calorimeter when unit mass is withdrawn.

The quantity $Lu/(u' - u)$ for which the symbol β is used is complementary both to the determination of heat capacity and to the latent-heat experiments of H and L. This quantity is measured conveniently at any desired temperature by observing in supplementary calorimetric experiments the third type of energy required to produce the necessary evaporation when a certain quantity of saturated liquid is withdrawn.

Thus three different types of experiments yield values of three quantities α, γ, and β, referred to certain temperatures. From these are derived the values of enthalpy of saturated liquid H, the enthalpy of saturated vapor H', and the heat of vaporization L. In addition to these three characteristic energy quantities, there also may be derived from the calorimetric data the entropies of the saturated liquid and vapor, and by use of the vapor-pressure data, obtained in separate measurements, specific volume and internal energy may be calculated.

The properties of saturated water and steam may be derived

from the calorimetric data, and the formulas by which these derivations are made are as follows:

$$H = \alpha + \beta$$
$$H' = \alpha + \gamma$$
$$L = \gamma - \beta$$
$$\phi = \int \frac{\alpha dT}{T^2} + \frac{H}{T}$$
$$\phi = \phi + L/T$$

in which the following notation is used:

$$\alpha = H - Lu/(u' - u)$$
$$\beta = Lu/(u' - u) = Tu\, dP/dt$$
$$\gamma = L + Lu/(u' - u) = Tu'\, dP/dt$$

where

H	enthalpy or heat content per unit mass of saturated liquid ($\epsilon + Pu$), referred to an arbitrary zero
H'	enthalpy per unit mass of saturated vapor, referred to the same zero as H
L	heat of vaporization per unit mass ($H' - H$)
u	specific volume of saturated liquid
u'	specific volume of saturated vapor
t	temperature on international centigrade scale
T	temperature in centigrade absolute
ϵ	internal energy per unit mass
P	vapor pressure at saturation limit
ϕ	entropy per unit mass of saturated liquid, referred to an arbitrary zero
ϕ'	entropy per unit mass of saturated vapor, referred to the same zero as ϕ.

The authors describe the alpha, beta, and gamma experiments, and how the data derived from them were reduced and formulated, and then how the values of the properties of steam were compiled and compared with values compiled by other experimenters.

It is said that additional experiments are now in progress on the range 0 to 100 C to furnish new experimental evidence on the heat capacity of water. The plans and equipment are said to provide also for new determinations of the heat of vaporization between 0 and 50 C.

Industrial Spectroscopy

MACHINERY (LONDON)

IN THE recent Second Conference on Industrial Physics, convened by the Institute of Physics and held in the physics department of the University of Birmingham (England) numerous optical instruments for use in industry were noted, among which *Machinery* (London) describes in its April 29 issue the Steeloscope.

The Steeloscope, says the article, is essentially a fixed spectroscope by means of which the presence of numerous elements, such as nickel, chromium, molybdenum, and others can be detected in steel bars or scrap by an unskilled observer. The instrument is provided with an eyepiece integral with a slide which is adjustable in a guideway formed in the end face of one of the two arms of the instrument. Graduations on the guide correspond to the characteristic spectral lines of the different elements, each graduation being marked with the appropriate symbol. An index mark on the slide can be brought to coincide with any of the graduations by adjusting the position of the slide in the guide. The eyepiece is thus set so that the lines, if present, can be observed. The light source is merely an arc struck between the sample and a fixed electrode. The sample is placed in a metal tray with which it makes electrical contact and is then moved toward the fixed electrode to strike an arc.

Quantitative estimation of the content of any metal in the steel can be determined approximately, it is claimed, by comparing the intensity of the characteristic lines with the neighboring iron lines in the spectrum. It is said that by using a number of standard samples containing various percentages of the elements which can be detected the observer can accustom himself to determine the range of the percentage within which the content lies. An interesting application of the device is said to be in the determination of manganese in carbon case-hardening steels. Successful discrimination can, it is claimed, be made between steels containing 0.6, 0.8, and 1.0 per cent.

Electrolytic Galvanizing

MINING AND METALLURGY

EDITORIAL comment in our sister publication, *Mining and Metallurgy* for June, 1937, conveniently reviews recent developments in electrolytic galvanizing. It seems that zinc 99.995 per cent fine is now a commercial possibility, and it has been found that the 99.99+ material permits the making of zinc-base die castings definitely superior to those made with 99.9+ zinc.

The high degree of ductility of this nearly pure zinc, the editorial says, suggested the coating of wire and sheets of iron or steel to make a product that would withstand severe mechanical deformation without cracking or flaking.

The proposed procedure for making such a product had two novel features: (1) The zinc would be applied by electrolysis, which would make possible a thick and uniform coat of 99.995 zinc; and (2) the plating would be done from solutions made directly from the leaching of zinc concentrate, avoiding the production of slab zinc for subsequent re-solution.

Early experiments disclosed that the customary acid pickling process for removing grease, sundry salts, and scale that coat the surface of newly drawn wire was not sufficiently effective in cleaning the wire for making an electroplated product of superior quality. To overcome this difficulty a treatment was devised that consisted in passing the wire through a bath of fused caustic soda. In this, iron oxide is reduced to metallic iron and other foreign matter is removed, leaving an ideal surface for the application of the zinc coat.

In 1933 a plant for electrolytic galvanizing was built at the Sparrows Point works of the Bethlehem Steel Co. and about a year ago a larger plant was erected at Bethlehem's Johnstown works. Together they have a capacity of 90 tons of wire per day. The preparation of the zinc-bearing solution is essentially the same as followed at the Sullivan plant. Roasted concentrate containing 68 to 70 per cent zinc is leached with return electrolyte from the cells; residual iron, silica, and lead are removed by filtration; and such metals as copper, cadmium, and cobalt are precipitated with zinc dust, leaving a solution of zinc sulphate that closely approaches purity.

The current density required is ten to twenty times higher than that used in depositing cathode zinc at Kellogg; and the time during which the wire is in the bath ranges from one to several minutes, depending on the thickness of the coat desired. The process is, of course, continuous, and the period of immersion is regulated by the speed of the passage. Emerging from the cells the wire passes through polishers or dies to "densify"

the crystalline coat and produce a smooth, polished wire ready for market.

Naturally, many problems of technical and mechanical procedure were met and solved. At present a pilot plant for the coating of sheets is in operation, but numerous questions remain to be answered before the erection of a plant for commercial production will be attempted. No claim is made that the electrolytic coating will or should displace hot-dip galvanizing. For many purposes the product of the older process has peculiar advantages. On the other hand, the sponsors of the electrolytic process are doing their best to "sell" the idea that the user eventually will save money if he will buy products that have a thick rather than a thin coat of zinc. Galvanized sheets and wire have not the best reputation. Thinly and badly coated products cannot resist, and should not be expected to resist, corrosion indefinitely. On the other hand, zinc far outdistances other protective materials in point of cost per year of service *if* it is applied to steel properly and in sufficient quantity. To whatever extent electrolytic galvanizing can improve the reputation of zinc-coated steel, it will help the zinc-mining industry.

Surface Stress and Wear

MACHINERY (LONDON)

PROF. N. SAWIN, of the Skoda Works, Prague, describes in the May 6, 1937, issue of *Machinery* (London) investigations made on the effect of surface stress on the wear of metal by means of a wear-testing machine. It is pointed out that the relationship between hardness and wear is sometimes apparently contradictory. In view of the extreme thinness of surface layers—as little as 0.005 to 0.02 mm in the case of small tools and not more than 0.1 to 0.2 mm in other tools—current methods of photomicrography or X-rays cannot be applied. Hence the author describes the Sawin-Skoda method.

Referring to Fig. 3, it will be seen that a highly finished cemented-carbide disk, 30 mm in diameter, is rotated at constant speed and under constant pressure against the workpiece. The disk is lubricated by a special lubricant which carries off the abraded particles. The griding action produces a slight impression in the shape of a cylindrical segment on the workpiece. On measuring the length of this impression by means of a microscope located on the machine, the volume thereof after a certain number of revolutions can be found from tables and the resulting volume can be taken as a measure of the resistance to wear.

It is said that the complete test, including setting up the piece, the actual operation, and the measurement of the impression, occupies five to six minutes. Practically no wear develops on the cemented-carbide disk.

The test may also be performed with a constant volume of impression, i.e., a constant depth of impression, the machine being stopped when the indicator of the precision gage shows the required reading.

By performing wear tests at different depths and repeating tests periodically on the same sample, it is possible to investigate the influence of different means of mechanical and heat-treatment. The total quantity of material removed serves not only as a measure of resistance to wear but also as an indication of the stresses in the surface layers. The larger the stress in the surface layers the shorter the time necessary to remove a certain volume of material by the cemented-carbide disk.

Wear tests of tool steels, received from well-known European firms, establish both the influence of different methods of surface treatment, for instance, milling, wet grinding, and dry polishing, and of seasoning, on the wear of materials at different depths up to 0.1 mm.

It has been shown that both wet grinding and dry polishing after hardening, in all cases, decrease the resistance to wear at a depth up to 0.05 mm by an amount which averages 25 per cent. For several materials the difference between the wear of surfaces machined by milling before hardening, and the wear of the same surfaces subjected after hardening to wet grinding or dry polishing, is as much as 50 to 60 per cent.

Surfaces finished by milling or turning, grinding wheel, or powdered abrasive before hardening, have shown after hardening a difference in their resistance to wear.

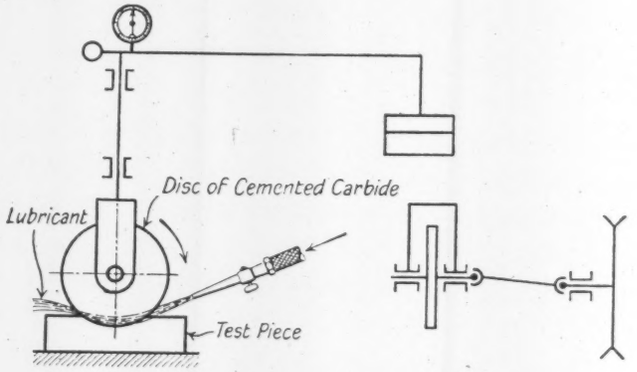


FIG. 3 DIAGRAMMATIC SKETCH OF WEAR-TESTING MACHINE

The influence of treatment on wear, and consequently on the internal stresses, is most marked at a depth of 0.02 mm and is considerably less at a depth of 0.1 mm. For several materials this influence is not apparent at 0.05 mm depth.

After a period of two months a reduction of the resistance of all materials when finished by grinding or polishing was observed in repeated tests. On the other hand, a slight improvement was apparent in several highly alloyed steels finished by milling or turning. The Johansson block sample remains unchanged at all depths up to 0.1 mm during test.

It is not possible to establish any relationship between the sensitiveness of materials to wear and their chemical analysis. It is also impossible to find a definite connection between the Vickers or Rockwell hardness, which is on some milled surfaces higher than after grinding, and wear and seasoning.

Powdered Metals in Industry

MINING AND METALLURGY

SOME interesting facts about powdered metals in industry are to be found in a brief paper on that subject by A. W. Hahn in the June, 1937, issue of *Mining and Metallurgy*. Ancient uses of powdered gold, silver, and bronze are referred to, and the more modern uses of powdered aluminum, for paint and in the thermit process, and for flares, bombs, and explosives during the World War, are mentioned.

About 10,000,000 lb of aluminum powder are used yearly for aluminum paint, 2 lb of aluminum being needed to cover 800 sq ft of surface. There are some 24 mills grinding aluminum paint for one company and eight for another.

Nickel powder is used as a catalyzer in the manufacture of some edible products, such as "Crisco," and in the hydrogenation of organic products in general, as by the oil companies for making aviation gasoline.

Many of the metallic powders are extremely fine; tin-lead powders will practically all pass a 300-mesh screen and about 70 per cent will be less than 18 microns. Among the metals that have been powdered are aluminum, antimony, bismuth, cadmium, chromium, cobalt, gold, iron, lead, manganese, molybdenum, nickel, paladium, silicon, silver, tellurium, tin, titanium, tungsten, vanadium, and zinc. Various finely divided metals as tin, copper, zinc, lead, and aluminum may also be sprayed on some papers, with a binder, and then passed through rolls, the paper being used for any decorative purpose, such as wrappings.

About the newest material to be atomized and flaked is lead. The material at first was too malleable to work easily. A lead paste is now made of 90 per cent metal and 10 per cent of mineral spirits. This makes a good protective coating when mixed with a suitable vehicle; it works well when used for coating iron or other materials that may be attacked by sulphuric or even hydrochloric acids. The finely divided metallic flaked lead can be applied to surfaces without priming. It can be used for coating zinc, or other metallic sheets, and when so used can be bent often without cracking the protecting layer. Some of the lead powder is so fine as to show a Brownian movement under the microscope.

Brake manufacturers find lead powders work well in brake-bands, for the material does not bind. Used in bearing greases, lead has lubricating properties that prevent scoring, and worn shafts and bearings can be resurfaced by the lead. Metallic lead may also possibly serve in place of lead oxide on pipe threads and pipe joints, as the material does not freeze in the joints if oxygen does not get to them.

The future for metal-powder plastics is promising, the prices are reasonable, and the uses should increase. Demand for aluminum paint is increasing, and the field for a metallic lead paint to resist corrosion should be large. Judging from the developments that have taken place during the past few years in the use of finely divided metals, there is every reason to assume that this field will become an important minor consumer of nonferrous metals if not one of the major consumers.

Research for Elevator Safety

INDUSTRIAL STANDARDIZATION

HOW THE Elevator Safety Code of the American Standards Association is kept up to date by means of research is briefly told by John A. Dickinson, of the National Bureau of Standards, secretary of the sectional committee on Safety Code for Elevators, Dumbwaiters, and Escalators, in the May, 1937, issue of *Industrial Standardization*. The researches covered in Mr. Dickinson's article were conducted at the National Bureau of Standards and are concerned with hoistway-door interlocks, undercar safety devices, and wire-rope tension-equalizing devices, and discusses how the elevator safety code is kept in step with increased speed of operation. A brief section deals with future problems.

Interlock tests were begun at the Bureau in 1922 and have continued since then with the result of bringing interlock devices to a high standard of reliability.

When the question arose as to whether annual tests of undercar safeties were desirable the chief engineer of one of the companies represented on the committee conducted a series of tests which demonstrated that more than 150 stops were necessary to wear that particular device to the point that the car could slide all the way to the pit. As the average life of an elevator is probably 20 or 25 years, it was obvious that an annual test was not detrimental to a well-designed and constructed undercar safety and the requirement for an annual test was retained in the code.

When the 1925 edition of the code was prepared it was evident that there were insufficient data upon which to base type-test requirements of buffers and undercar safeties. A research, financed by manufacturers of elevators and elevator equipment and by insurance companies, was undertaken at the Bureau. A study of buffers covering a period of three years resulted in test specifications which took into account not only the effects on passengers during a buffer stop but such questions as, allowable play of the plunger in its guides, maximum allowable decrease in oil level for a given number of operations, permissible change in performance due to mixing of air with oil which occurs to some extent in all buffers upon repeated operation, ability of the plunger to return promptly to its fully extended position after the car has been raised, and strength of the whole equipment as determined by an overload test at its maximum rated speed. These requirements were incorporated in the 1930 edition of the code, and certified buffers are now required in several cities, states, and federal departments.

In cooperation with The American Society of Mechanical Engineers the Bureau recently completed an investigation of the strength of worn wire ropes. It was found by comparing results of tests on worn rope taken from service with charts published by John A. Roebling's Sons Company relating to the determination of the service life remaining in wire rope, that, if rusted or corroded ropes were excluded, close agreement was obtained.

Results of tests will soon be available on four elevator installations, two of which are equipped with cable equalizers and two with the conventional cable hitch.

In the first edition of the Elevator Safety Code (1921) the curves for the factor of safety of cables extended up to 800 fpm or 100 fpm more than the maximum permitted by the New York City Elevator Code then in force. Before the next edition was printed in 1925 there were several installations running 800 fpm. The 1925 code carried its curves to 900 fpm, but before the next revision there were installations running 1000 fpm. The 1931 edition gave curves to 1500 fpm and as a proof that history repeats itself, we find today cars being run at speeds of 1200 and 1400 fpm, and even 1600 fpm in one or two experimental installations. The 1935 code, however, does not carry the curves beyond 1500 fpm, as it is doubtful if allowable speeds will be increased appreciably in the next few years. The reasons are threefold:

1 The change in air pressure on passengers' ears at the higher speeds is unpleasant. For example, in the Empire State Building the change of air pressure from the street level to the top of the travel of the first lift corresponds almost exactly to 1 inch of mercury, or a decrease of 3.3 per cent. As this change takes place in somewhat less than a minute, it is quite annoying to some passengers. For this reason pilots of air liners are careful to ascend and descend at rates of less than 1000 fpm.

2 As the travel necessary to build up these high speeds increases as the square of the speed (the maximum allowable acceleration being limited by physiological effects), high speeds may be used only where exceedingly high rises are encountered. For a speed of 1600 fpm, the accelerating distance is considerably over one hundred feet and the stopping distance is at least 80 per cent of the accelerating distance so that a travel of about 200 ft is required to start, build up a speed of 1600 fpm, and then stop. An increase to 2000 fpm would increase the travel distance more than 50 per cent, or a distance in excess of 300 ft would be required to start and stop at this higher speed.

3 The power necessary to accelerate the masses involved becomes prohibitive. In some actual installations the power re-

quired to accelerate the car, hoisting ropes, counterweight, and rope compensation is several times the power necessary to handle the fully loaded car at contract speed. For a 2000-ft rise (which is about the maximum for which code factors of safety could be met with a car of usual steel construction) it has been estimated that the accelerating current would be *ten times* the normal running current.

Increasing speeds necessitate additional requirements of safety equipment. For example, at high speeds it has been found quite impractical to stop the governor rope suddenly. The type of rope-grip jaw used for slower speeds will, at the speeds used in some of the high-rise express elevators, act like a pair of cutters, and cases are on record where a governor rope has actually been severed by the sudden tripping of a governor. For high-speed equipment it has been found necessary to provide a long, parallel type of rope-grip jaw rather than two small eccentrically mounted circular arcs. The long parallel jaws distribute the clamping force over a considerable section of the rope and permit a certain amount of "pull through," thus allowing the energy of the moving governor rope to be absorbed gradually. The momentum of 1000 lb of governor rope running 1000 fpm, or faster, is very considerable.

Relaxation of Copper

AMERICAN SOCIETY FOR TESTING MATERIALS

WITH the present-day tendency to employ higher temperatures in various industries, it is becoming of greater importance to investigate the behavior of metals at elevated temperatures more extensively than was necessary in the past, writes J. Boyd in a paper entitled "Relaxation of Copper at Normal and at Elevated Temperatures," read before the American Society for Testing Materials at its annual meeting, New York, N. Y., June 28 to July 2.

In the study of the mechanical properties of metals at elevated temperatures, the means most usually adopted is the long-time creep test in which the test piece, held at constant temperature, is allowed to creep (or elongate) under the action of a constant force.

When a metal is subjected in practice to conditions similar to those under which it is tested in the ordinary long-time creep test, such tests furnish good and reliable information. In many applications, however, the conditions of service are somewhat different from those which prevail in the usual creep test. For example, bolts tightened on two relatively rigid flanges, and held at a given temperature will have their length kept practically constant but their stress will be allowed to decrease. The question then arises; Can the decrease in stress be predicted from creep tests? To answer this query it is of course necessary to determine the manner in which the stress decreases by conducting tests under the same conditions as those to which a bolt is subjected. Such an investigation may also provide an answer to the converse question: From a knowledge of the decrease of stress at constant length, can the creep under constant stress be determined?

The phenomenon of the decrease of stress at constant length, such as occurs in the case of the bolt, has been called relaxation. Some investigation of this phenomenon has been made, but few of the methods used have attempted to produce pure relaxation conditions. In the majority of instances, the goal of the experimentation has not been to describe the laws of relaxation but to obtain creep data in a more rapid way than was possible from tedious long-time creep tests.

During the past two years, relaxation tests have been made at East Pittsburgh with an apparatus designed to eliminate the principal difficulties of former methods. Special attention has been directed toward fulfilling the conditions of pure relaxation, that is, measuring the decrease in stress while the length of the test piece is carefully kept constant. A special apparatus was designed for this purpose, the principle of which may be best understood by referring to Fig. 4. Let a bolt of a given material be stretched by tightening, from the unstressed length l_0 to the stressed length l. The stress-extension curve is then

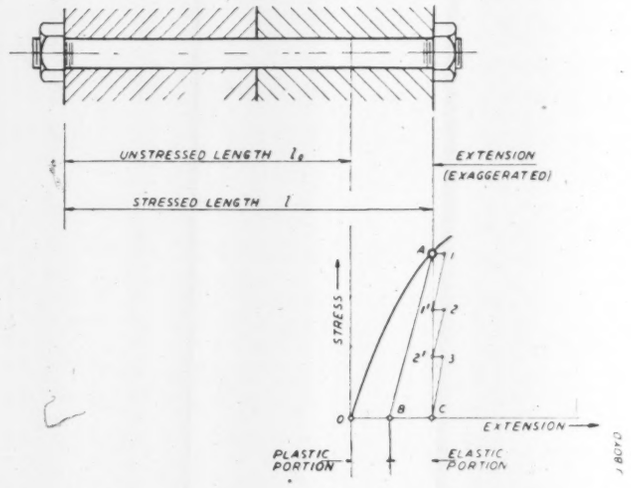


FIG. 4 STRESS-EXTENSION DIAGRAM FOR A BOLT TIGHTENED ON RIGID FLANGES

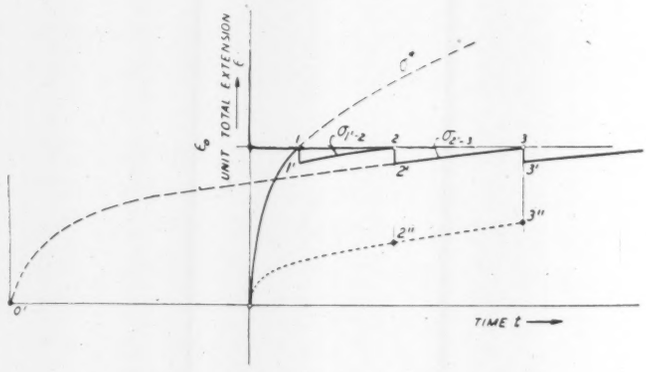


FIG. 5 CONSTANT EXTENSION APPROXIMATED BY AN INTERRUPTED CREEP TEST

shown as *O-A*. If the load were then removed, the approximately straight line *A-B* would appear as the unloading curve. The elastic portion of the extension *B-C* would be regained, but the plastic part, *O-B*, would remain as a permanent deformation. However, suppose the length *l* of the bolt were held constant for an indefinite time; the stress would then decrease but the extension would stay constant so that the unloading line would be represented by the vertical line *A-C*. In experiments described in the complete paper, the line *A-C*, which represents the conditions of relaxation, is approximated by a series of very small steps (those shown in the figure are very much exaggerated). The principle by which this was carried out in the special apparatus is as follows: The test specimen is first stretched to the length *l* after which the applied load causes the test piece to creep, so that, at first extension takes place at constant stress (line *A*-1 in Fig. 4). A portion of the load is then removed and the specimen contracts elastically along line

1-1′. The mechanism is designed to bring this length back to its initial value *l*. Since creep also takes place at this reduced stress, extension again continues along line 1′-2, but at a slower rate. At point 2, more of the load is removed and the cycle repeated indefinitely. By making the steps very small a true relaxation test is approximated and the decrease in stress with time may be observed.

Fig. 5 illustrates the relation between extension and time for a succession of finite unloadings such as were considered in Fig. 4. The lines *A*-1, 1′-2, 2′-3, etc. are the creep curves corresponding to the lines having similar marking in Fig. 4.

In summarizing the results of the studies reported Mr. Boyd said:

(1) The relaxation of copper at room temperature and probably up to about 200 C may, for practical purposes, be represented by an expression of the form

$$\sigma = \sigma^* [1 - A \log (1 + Bt)]$$

where σ is the stress at any time t, σ^* is the initial stress, and A and B are constants.

(2) A marked increase in relaxation takes place when the temperature is raised above about 80 C. At 200 C the stress is estimated to fall to about 20–25 per cent of its initial value in a service time of 20 years.

(3) Recovery effects tend to decrease the creep rate found in the early part of a relaxation test.

(4) The dissimilarity between the speed laws for decreasing and for increasing stress gives rise to rather large amounts of relaxation.

(5) Further creep and relaxation tests are at present under way and it is hoped that they will throw additional light on the subject.

The work reported by Mr. Boyd was done under a grant received from the Engineering Foundation during the years 1935–1936 and was carried out with the facilities offered by the research laboratories of the Westinghouse Electric and Mfg. Co. in cooperation with the University of Pittsburgh. The problem was suggested by Dr. A. Nádai, of the Westinghouse Research Laboratories, who influenced the work as it progressed.

Something About Wood

INTERNATIONAL REVIEW ON TIMBER UTILIZATION

LEST WE become too sanguine about so venerable a material as wood, it is well to consider the *International Review on Timber Utilization* for April, 1937, in which are assembled reports from nations all over the world.

From Switzerland, for example, comes a comment on the electrical seasoning of wood which says that a furniture concern has more than 20 electrically heated kilns. One of the advantages of the electric kiln is said to be the reduction in time-consuming subsidiary labor. It is further stated that the initial cost of the electric kiln is lower than that of a wood-fired kiln. While data on operating costs are fragmentary, experience has shown that the "complete" drying of green wood calls for 200 to 590 kwhr per cubic meter of wood, but that 80 to 150 kwhr suffice for preseasoned timber.

One plant design mentioned provides a double metal wall with asbestos or wood-fiber board filling. Metal parts are painted with a lead composition to protect against rust and also with a heat-resisting aluminum-bronze coating. Presence of condensed steam calls for safeguards to electrical plant and contacts. The electrical heating plant and air-conditioning plant may be placed on one side of the drying chamber and separated from it by a close-meshed wire netting, with the air-extraction room similarly separated on the opposite side. A fan is connected to an air-inlet pipe, so that the air is forced through the heating elements and past the conditioning device where it becomes saturated with moisture before passing into the seasoning chamber itself. Thence it flows into the air-extraction room, from whence it is drawn back into the heating room for renewed conditioning. The heating elements are controllable in three stages. In most installations special rates for use of night current are available.

Several reports on wood gas are also to be found in this publication. From Germany is reported a five-year experience with trucks operated with wood-gas producers. One author states that he would never return to liquid fuels even if the cost were reduced by 50 per cent. Operation of a producer with grates of a porcelain material developed no troubles due to breakage. Engine compression ratio of 1 to 10 was found to be too high. For strongly built engines a ratio of 1 to 8 was satisfactory, and it is said that specially built engines with a ratio 1 to 6 work well provided there is a sufficient margin of power. In the case of a fleet of trucks mentioned, which are operated practically day and night with relief crews, one has run 12,000 miles and another 14,500. There have been no breakdowns due to use of the wood gas. Pistons were removed at the end of 10,000 miles to increase the compression ratio, but it was decided to revert to a ratio of 1 to 8. No wear was noticeable on the pistons.

The concern using the wood-gas trucks is in the milling business and it is said that profits were made from the savings in truck operation rather than from sales of the product. The wood fuel is cooperage waste costing 5 marks per 100 km. The year's cost was 3500 marks for each truck running about 70,000 km per year. With gasoline and the same trucks the cost was 22,400 marks, based on fuel at 40 pfennig per liter and a consumption of 80 liters per 100 km.

A report from Switzerland states that the Swiss Forestry Association has taken up the organization of filling stations for wood-gas-burning trucks in order to assure users of convenient sources of supply in cross-country trips. At present two grades of wood fuel are provided, hogged wood, cut with rotating knives that turn out pieces with surfaces oblique to the run of the grain and rather unevenly sized, and block wood cut up in uniform size with ax and saw. Only sound hard and soft wood is used for either grade. Fuel prices have been fixed at 6 Swiss francs for block wood and 5 francs for hogged wood, exclusive of packing, for 100-kg lots ready for use in the generator. Quantity discounts are provided for lots of 400 to 1000, and for more than 1000 kg.

Wood impregnated with metal, possessing in part the properties of natural wood and those of the metal, is reported from Germany. The material may be sawed, bored, planed, nailed, turned, glued, and polished as with natural wood. Notable properties are resistance to climatic influences and chemicals, lack of tendency to split, break, blister, or splinter. The new material has a specific gravity of about half that of the metal, swelling and shrinking are reduced to a minimum, and resistance to fire is obtained. Hardness and strength properties exceed those of wood.

Another material mentioned is a plywood whose surface is coated with steel, brass, copper, aluminum, monel metal, or sheet zinc, with a reinforcement of metal running through the center. The metal is cemented to the wood by means of an especially adhesive glue in such a manner that moisture is excluded. Particular properties are resistance to impact and pressure, resistance to fire, heat insulation, resistance to chemicals, and light weight.

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Engineer and Engineering

[About a year ago several letters discussing the word "engineer" appeared in MECHANICAL ENGINEERING. Some of these were written for the purpose of urging that "engineer" be restricted to apply to professional engineers only, while others upheld, on grounds of common usage, the right of engine drivers and operators to apply the term to themselves. These expressions of opinion brought forth the letter by Mr. Colles published on this page. A copy of this letter was forwarded to Mr. Lough: Pendred, editor of *The Engineer*, who, in turn referred his reply to it to Mr. Rhys Jenkins, eminent engineering historian and biographer. Mr. Pendred's letter and Mr. Jenkins' reply to it are published with the letter by Mr. Colles. The three communications present some interesting facts and points of view about two words of considerable importance to all engineers.—EDITOR.]

TO THE EDITOR:

Discussion of the term "engineer" is a revival of the old subject which has been before our society since it was started in 1880.

To go back to the beginning, our word "engine" comes from the French, who got it from Latin *ingenium*, which, in classical times, meant a mental quality (talent) and as such was perpetuated in French and then in English (as in Chaucer).

Its first use to mean a mechanical device or contrivance apparently dates from the second century A.D., when it was applied by the Romans to their military machines—catapults and ballistae—for hurling projectiles. These machines reached a climax of development in the Eastern empire about the time of Belisarius, sixth century, after which they waned, along with the art of siegecraft in which they were principally used. When, after ten centuries, this art was revived with the introduction of gunpowder, nobody thought of calling guns and cannons "engines," but the term "ingénieur" was current in France, the leading military nation, to mean one skilled in siegecraft. So Shakespeare refers to "the enginer[1] hoist with his own petar," meaning a constructor of mines for blowing up city walls and the like. As military art was developed, the "ingénieur" assumed a more and more important rôle in the military operations and took charge of all kinds of works, as bridges and roads. Then, as these works began also to be required in civil (i.e., nonmilitary) life, came the term "civil" engineer, which was current in England long before anybody had thought of applying the term "engine" to a prime mover; there were no "prime movers" then and surely neither Watt nor his immediate successors would have understood this term.

The term "engine" developed independently of "engineer." It appears to have fallen into disuse, or rather, perhaps, never was used at all in the sense of a machine (we have "gin" from it in the sense of a three-pole hoisting frame, also a trap) until mechanical devices began to be used in industry. Who first applied it, whether Newcomen or Watt, to the steam engine, I cannot say; but certain it is that "engine" then, in English—the corresponding French term was obsolete—was a synonym for machine, and never used in its modern sense of a prime mover. So we have (end of eighteenth century) the "cotton-engine" (now *gin*) of Eli Whitney and the "rose-engine," a lathe for engraving intricate geometric designs. As the steam engine, in its many applications, rose to front rank among machines, "engine" came to mean a steam engine and nothing else; indeed, up to the time of my boyhood the popular idea of an engine (with long *i*!) was a locomotive. It is only in the past 50 or 75 years that other prime movers were developed and they were all, except the dynamo, called engines; indeed, I remember in an old schoolbook the description of an "electrodynamic engine."

So then we find that the French word ingénieur and its equivalents adopted into every European language to mean exactly what we mean by *engineer* in a professional sense. Nobody in Europe (including England) ever thought of calling a mechanic an "engineer." The word engine was confined to England and was obsolete or never adopted in the other languages. In those countries an engine operator was a mechanic or machinist (mécanicien, machiniste, etc.). From "engineer" was developed engineering, at first military, then civil engineering, and from civil other branches—mechanical, mining, and so on. In England the transition from "civil engineer" to "mechanical engineer" was quite natural and allowed no chance for confusion.

In America the case was different. When the steam engine was introduced here and became *the* engine, there were no engineers. I doubt if there were civil engineers *eo nomine*, and certainly there was no such profession as designer of engines. Our steam engines—or at least their designs—came from England for many decades. What more natural, then, than that the operators of engines should appropriate the unused term "engineer." In fact I can't accuse them of appropriating it, since it was more likely fathered upon them by the public! There is nothing new in such novel application of a word by the Americans. One need not search the dictionary very far to find plenty of such misused words: "car," for instance, to mean a railway conveyance, whereas in England it was a two-wheeled cart and nothing else; or, "ferry" in western United States to mean a boat operating on a ferry.

So when at length, along in the eighties, there got to be enough of us professional engineers engaged in designing and building machinery to form a society, up we popped with the term "mechanical engineer," imitating the English usage and society; but *here* it had already been appropriated by the mechanics; leastways, the then "engineers" were all mechanical by necessity. With the civil and other branches of the profession there was no friction, since there was no room for misunderstanding, but what more natural than that the public, not well informed in such matters, should fail to discriminate, and that a prominent lecturer before our society should urge us not to join the machinists' strike!

Well, then, here's a how-de-do. Seems like we came along too late.

[1] It was originally "enginer" not "engineer," in our language.

With what grace can we now demand that the operators get off the word, who have sat on it and made it their own for more than half a century before we were heard of? I should judge we'll have to accept the situation "as is" with what grace we can, remembering the lines of Bret Harte:

"If, of all sad words of tongue or pen
The saddest are: It might have been;
More sad are these we daily see:
It is, but hadn't ought to be."

GEORGE W. COLLES.[2]

TO THE EDITOR:

I have read the correspondence about "engineer" and "engine" in MECHANICAL ENGINEERING.

Murray[3] was a very sound man, but the full history of the word [engineer] has never yet been solved. If you have not done so already you will find it worth while to turn up the short article on "Engineer" in the Encyclopaedia Britannica. I suspect the word just "occurred" as so many do in our beautiful and flexible language, and had been in use for a great many years before it got into print, its meaning getting extended as development required. Originally, "engine" certainly meant a machine or device. Thus Worcester in his "Century of Inventions" speaks of "an engine portable in one pocket" for sinking ships, and of an extending ladder as an "engine." On the other hand he speaks of his famous pumping engine not as an engine but as a "water works" and pumps of various kinds were called water works for many years. Worcester did, however, in 1663 speak of his "water-commanding engine." But by the end of the seventeenth or early in the eighteenth century, "engine" was in use in the now most generally used meaning, for Newcomen's engines, 1712, were so called.

The view that "engine" nowadays invariably means a prime mover is, I should say, very nearly correct; the clock- and watch-making trades probably adhere to the old meaning as in "engine turning," etc., but in other trades and occupations "engine" has been taken away from its old connection. For example a mining windlass was a "gin" = "engine," but now a winding engine is not the winding gear itself, but the engine that drives the gear.

Personally, I have for long held the opinion that the term "engineer" really belongs to the mechanic. It was appropriated in a very natural and obvious way by the profession as the science of engineering progressed. The original engineer was the man who drove engines, and as in many cases he was not distinguishable from the man who invented and even made them, the term applied naturally to both. It must be remembered that the early mechanical engineers, Watt and Trevithick, included, and of course all the inventors of the locomotive, were mechanics on precisely the same social level as the mechanics of today. Hence it seems to me that the mechanics have the first claim on the word. One of our strongest trades unions was called the Amalgamated Society of Engineers, founded in 1852. As far as I can trace that is the first time the term "engineer" was "officially" adopted for mechanics. It is worth noting that in 1822 there was a Union of Enginemen.

You ask the very interesting question why this paper was called *The Engineer*. No records exist from which a definite answer could be given, but I suspect that there was in the mind of the founder—Edward Healey, 1856—a desire to differentiate his paper from the *Mechanics Magazine*, now extinct, but then the only engineering newspaper. It is clear that at that time engineering as a profession, not merely as a mechanical craft or trade, had become fairly well established. The Institution of Mechanical Engineers was founded in 1847 and was never a mechanics' society, though Stephenson, originally a mechanic, was its first president.

To summarize the progress of the word: (1) engineer originally meant the man who drove the engine, (2) owing to the fact that the driver of engines became also the inventor of engines the term was applied also to the inventor and maker, (3) as technology increased the status of the engineer improved and ultimately (4) specialization came into being and a variety of classes of engineers—industrial and professional—arose.

As I feel sure it will interest you, I enclose a copy of a letter received from Mr. Rhys Jenkins.

LOUGH: PENDRED.[4]

The Gabled House,
Hermitage,
Berks.

DEAR PENDRED:

As to the word "Engine" you are quite right, the Marquis of Worcester does use the expression "Water-Commanding Engine," but not, I think, in "The Century." It occurs in some of his letters and in the Act of Parliament (1663) protecting his invention. "The Century" does, however, make use of the term "engine" for seven or eight of the inventions, usually for what we should now call devices or contrivances, for instance, that which you mention: No. 94 "A little engine portable in one's pocket" (for forcing open doors or gates).

The word was in use long before Worcester's time and remained in use long after applied in much the same way. In the period say from 1690 to 1720 it may be found applied to a great variety of things, including burglar alarms, apparatus for raising water, ore stamps, sugar-cane mills, and diving apparatus. There were riots about the use of "engine looms" and Loube's patent (1718) is for the invention of "three sorts of engines" for the preparation of silk. In the same year (1699) that Savery showed the model of his fire engine to the Royal Society there appeared in one of the London newspapers an advertisement of another of his inventions—"the *engine* for grinding . . . looking-glass plates," and the year before he had published a book about his "Rowing *engines*" (paddle wheels worked by men). Even today "engine" has at least one quite important application, apart from that to motors, that is the "beating-engine" used in the manufacture of paper, and in the textile industries I fancy that "carding *engine*" is still in use, although carding machine is the common term. Possibly the fact that the term "fire engine" had been applied to Savery's apparatus led to its being adopted very soon for Newcomen's engine. In 1716 the Coalbrookdale Company supplied castings for "ye Fire Engine" and in 1725 we read of "ye Fire Engine at Tipton." The well-known Barney print of 1719 bears the title "The Steam Engine near Dudley Castle," but "fire engine" remained the recognized name for the engine for long after.

Engineer. About this word I do not agree with you at all. You have forgotten Shakespeare's "the engineer hoist with his own petard" (somewhere in Hamlet). There were engineers in the service of the English kings from early times. I imagine that in the beginning their function was the construction and maintenance of catapults and other instruments of war, but we find them doing all sorts of work.

However, to come to Savery's time. You will remember the discussion as to what the "Captain" before his name implied; how some people maintained

[2] Rose of Sharon Garden-Ranch, Rosharon, Texas. Mem. A.S.M.E.

[3] Editor of the "New English Dictionary," published by the Oxford Press.—ED.

[4] EDITOR, *The Engineer*, London. Mem. A.S.M.E.

that he had been a "Captain of Engineers" and I had pointed out that although there were engineers in the army there was no corps of engineers, so there could not be such a title as "Captain of Engineers." At this period Sir Martin Beckman had the style of "his Majesty's chief engineer."

However, we had engineers other than those in the royal services. George Sorocold is referred to on at least three occasions as "the great English engineer." His chief work was the water supply of towns by pumps worked by water wheels.

I cannot at the moment say when the term "Civil Engineer" was introduced, probably it was adopted to distinguish from military, i.e., Royal Engineers.

The first man to call himself a "mechanical engineer," so far as my knowledge goes, was William Fairbairn in 1830. In the same year I have a note of a "mechanical draughtsman."

You will see from the foregoing that I cannot accept the statement that "Engineer originally meant the man who drove the engine." I ask, with some diffidence, is it a fact (with the single exception of engineers on ships) that the man who drove the engine was ever called engineer? As you know, I have been out of touch with engineering practice for many years, but I am quite certain that in my young days, the locomotive man was a "driver" or an "engine driver;" the man who had charge of a mill engine was the "engine man." The "Engineer" was the official who had charge of all the machinery of the mill. The first engine man of whom there is any record, John Hilditch, described himself in 1725 as "Manager of ye Fire Engine at Tipton."

Without search, I cannot say much on the question when it became the practice to call establishments in which engines were made "engine works" or "engineering works." When Boulton and Watt started, the engine work was done in a part of Boulton's factory called the "engine yard," but when a separate works was set up it had the title of "Soho Foundry." The name "foundry" was favored for a long time; Matthew Murray had "The Round Foundry" in Leeds; the celebrated Cornish engine works, Hayle, Copperhouse, and Perran were all foundries. Then there was the well-known locomotive works, the Vulcan Foundry, and many others.

I am very pleased to learn that the history of some of our engineering words is being discussed. The two words now in question would be well worthy of a careful critical examination. What a delightful thing it would be to enter upon a discussion of workshop vocabulary generally—the borrowings from the animal kingdom, camel, crocodile, donkey, dog, monkey, sow, pig, elephant; then the crow, the crane, the dove, fish, butterfly, caterpillar, worm; Jack, Jim, Jenny, Billie, and hosts of others.

This letter has run to greater length than I expected. I hope it won't bore you.

RHYS JENKINS.[5]

Steamotive

TO THE EDITOR:

The design of the Steamotive unit[6] places emphasis upon high steam pressure and temperature, and these initial conditions, in fact, contribute to good overall performance of the complete locomotive. But several other factors will seriously affect the result. One of these is auxiliary power consumption. Another is efficiency of transmission to the driving wheels. A third is condenser performance.

The efficiency shown by the curve at the top of Fig. 11 appears to be a gross value, in which auxiliary power consumption is ignored. To what extent is this efficiency reduced when referred to the complete self-contained generator, supplying its own auxiliary power? That the auxiliary demand will mount rapidly with increasing draft pressure, i.e., at high output is evident.

Electric transmission to the drive wheels involves a loss of about 15 per cent. European turbine locomotives, built between 1920 and 1930, invariably employed gear transmissions. Starting characteristics were reported exceptionally good. Reversing was accomplished by gears or a special turbine wheel. Wearing qualities of the gears were satisfactory. The loss in gear transmission in that case does not exceed 5 per cent. The electric transmission, adopted in the present case, entails about three times as much power loss as well as extra cost. Removal of electrical equipment should relieve the rigid space restriction said to have been imposed upon the steam generator.

Condensation is an obvious difficulty. Ljungstrom used 6 to 7 sq ft of dry radiation per horsepower, and secured a 22 to 26-in. vacuum in the cool climate of Sweden. Eventually, he abandoned condensation, believing that the gain which was accomplished did not justify the initial and upkeep costs. Wet radiation is impractical where local water is poor.

The proposed turbine-electric locomotive, being designed for exceptional efficiency, invites comparison with the already established Diesel-electric type. The paper states that a 40,000-lb-per-hr boiler will serve a 2500-hp locomotive, a rate of 16 lb per tractive hp-hr, after all losses. On this basis and computing from test-curve data, 1.22 lb fuel per tractive hp-hr will be used at full load. The corresponding figure for a Diesel-electric locomotive is about 0.50 lb, and the ratio of these figures is 2.44. This ratio is modified by the higher price of suitable Diesel fuel, but the cost advantage in favor of the Diesel remains at 80 to 90 per cent. Therefore, the turbine-electric locomotive is unlikely to become a serious competitor. Should it prove capable of burning pulverized coal, a different situation would exist at least in coal-producing areas.

E. S. DENNISON.[7]

TO THE EDITOR:

The excellent paper entitled "Steamotive" certainly has evoked interesting memories of an early development of "flash boilers." In September, 1898, Prof. Elihu Thomson, the then living American dean of electrical engineering, said to me:

> One of the coming developments will be the automobile, and I believe steam will be the motive power. To make a satisfactory steam carriage with a light and compact power plant, we must have
>
> (1) A boiler which is absolutely safe to be placed in the hands of ordinary people, one which will not require supervision from the U. S. Steamboat Inspection Service.
>
> (2) The fuel must be safe, kerosene or fuel oil, *no gasoline*.
>
> (3) Steam pressures must be high and steam superheated to reduce water consumption.
>
> There is no other boiler better suited to meet this specification than the so-called "flash boiler," first proposed by Serpollet in France.

A "flash boiler," as we term it, is one *continuous* tube coiled or in folds crisscrossing each other, into one end of which water is pumped and, from the other end, steam issues in superheated state. It is a water-tube boiler with practically no water capacity and rela-

[5] Former Senior Examiner of the British Patent Office.

[6] "Steamotive," by E. G. Bailey, A. R. Smith, and P. S. Dickey, MECHANICAL ENGINEERING, December, 1936, pp. 771–780.

[7] Engineer in charge of Diesel-engine development, Electric Boat Co., Groton, Conn. Mem. A.S.M.E.

tively great internal resistance to the flow of both water and particularly steam. It is absolutely safe. I have been sitting practically on top of one of these boilers with 1500-lb pressure and tubes red hot, exploding, and all it said was "puff." But Professor Thomson continuing said:

> I will build a flash boiler in which air, oil, and water will be fed by a composite triple pump in the following ratio per volume; air, 12,720; oil, 1; water, 7.8. I will also build a suitable steam engine for high pressures and temperatures in which poppet valves with variable cutoff admit steam into a clearance space and the exhaust thereof leaves by a row of exhaust ports, uncovered by the piston in its lowest position.

In other words, Professor Thomson invented the uniflow steam engine, which later was elaborated on by Stumpf in Germany and is today widely used. I built the carriage and the first flash-boiler unit with triple pump installed. Fig. 5 of the paper shows why this particular auxiliary unit was not a success.

On different load ratings, the proportion of burnt fuel to water evaporated did not stay constant. The auxiliary set in the Thomson carriage was driven by hand until we had steam enough to start, and, then, it was driven by the engine direct through an overrunning clutch.

The boiler was made of square slabs of machine steel drilled with interconnected passages for water, while holes drilled between the water passages let the hot gases through from the combustion chamber. The latter had a firebox lined with refractory material into which a blowtorch projected from the rear fitted into the firebox centrally in the form of a taper plug held in place by a bayonet joint. The torch proper had openings for oil and air. To start it, the plug was removed, and a piece of waste saturated in kerosene lighted and thrown into the firebox; the joint was then closed and the air and oil pumped by hand in definite proportions. This first boiler was not a success, as distortion by heat caused leaks and clogged the holes through which the fire passed. Professor Thomson told me to build a flash boiler free from these objections. Not having any boiler experience, I consulted an elaborate catalog, then published by Babcock & Wilcox Co. I distinctly remember pictures of a graveyard with tombstones and the terse remark, "such and such a boiler died a natural death because it had no circulation." This was hardly encouraging advice to build a boiler which had no circulation, water being pushed in one side and steam coming out the other. Serpollet in France insisted that, to prevent the spheroidal state, a flash-boiler tube should be flattened down so that the two walls would be very close together, say about $^1/_{32}$ in. apart. This did not appeal to me as a practical design, so I took a circular tube of standard make instead and placed a spirally twisted plug of square cross section, which could be removed for cleaning purposes and removing of scale, in the center. These tubes were cross-connected by U-shaped return bends with unions, and a kerosene burner with natural draft located below the bottom of these nests of horizontal tubes.

However, due to expansion under heat, these union joints would not stay tight, and, finally, I built up a boiler by bending extra-strong $^3/_8$-in. seamless steel pipe into square-shaped grids and then electrically welding the end of one grid to the next above it so that the bends of the following grid were at right angles to the former and so on, until a nest of bends eight to ten layers thick would be formed, which was free to expand in all directions and yet was in reality one single long tube without leaking joints. We found that the spheroidal state could easily be avoided by raising the internal pressure to 500 lb before leaving the engine throttle; a maximum-flow diaphragm was introduced ahead of the throttle. This type of flash boiler proved satisfactory and formed the basis of more than ten experimental carriages built and used daily by officials of the General Electric Co., both at Lynn and Schenectady in 1902. In these carriages, water and oil were pumped in substantially definite proportions as controlled by the pressure of the boiler. Fuel was furnished slightly in excess of the correct fuel-to-water ratio and, when steam became too hot, a thermostat cut off the burner until the temperature fell sufficiently.

Later, in a touring car, the boiler was placed in front and a condenser added, permitting journeys of 150 miles to be made without requiring additional water. No safety valve was used; instead, an accumulator containing compressed air was connected to the water inlet to the boiler through a check valve, with a hand-controlled by-pass around it. When the carriage was stopped suddenly, the fire was automatically reduced to gravity feed, and the excess boiler pressure forced water back into the accumulator where it was locked until released by the operator when starting the carriage. This was highly practical.

In 1906, the New York Central Railroad, while starting the electrified service between New York and Harmon, required a kerosene-heated boiler for supplying steam to coaches. A flash-boiler unit was first built for that service. Then an electric flash boiler, which took 241 kw to furnish the equivalent of 30 hp at 90 lb and 326 F but had a thermal efficiency of 95.6 per cent, was built to comply with the law prohibiting any gases in the Grand Central Station and the tunnel. The rail-car question was then being agitated, and the New York Central wanted a 200-hp flash boiler for such a purpose. A half unit of 100 hp was built and tested at the Lynn Works in the summer of 1907. The controls were automatic, the steam pressure acted directly on the oil pressure to the burner and indirectly on the water supply and on the steam temperature through a thermostat on the oil supply alone. The complete boiler was never built, owing to the steam pressure being limited to 300 lb and temperature to 500 F by the Interstate Commerce Commission. They had no experience with flash boilers, and the size, weight, and cost made the railroad officials turn to gas-electric equipment instead.

The White Co. of Cleveland had placed a large number of automobiles with gasoline-fired and thermostatically controlled flash boilers on the market but abandoned their manufacture and built internal-combustion engine automobiles instead. We, in the General Electric Co., took the same stand and concentrated on rail cars with gas-electric drive and later Diesel-electric for switching locomotives.

I have given this history of flash-boiler construction to bring out in relief the advance made in this development as evidenced by the paper and to show how it will compete with Diesel-electric plants for a self-contained traction unit.

Advances over previous art include:

(1) Pressure of flash boiler raised to 1500 lb.

(2) Temperature raised to 950 F.

(3) Improvements brought about by domestic-oil-burner engineers, utilizing forced draft exclusively in connection with measured oil supply and electric ignition.

(4) Advent of Nichrome alloy for high-temperature work.

(5) Apparent willingness of now accepting high pressures and temperatures in a steam generator of the *flash* type as contrasted by water- or fire-tube boilers with hot-water capacity.

(6) General advance in the engineering of controlling devices unknown before.

(7) The advent of the steam turbine. The paper stresses the fact that this unit was designed primarily to be used in connection with a steam-turbine unit furnishing power to energize electric-traction motors on a main-line locomotive for the Union Pacific Railroad. Such a locomotive will become a competitor of the Diesel-electric locomotive, having now reached substantially the same dimensions.

In what manner will it excel?

What is the thermal efficiency of a brake horsepower delivered by the turbine shaft to the generator? In a Diesel from 32 to 34 per cent can be confidently expected.

What is the approximate weight of the condenser needed to return exhaust in the form of hot water to the hot-water well?

In the tests mentioned, the auxiliary was started from a shop plant. Isolated from such a source, how will it be started, by storage battery and electric motors or by compressed air?

The development of this Steamotive is certainly a fine example of engineering but will undoubtedly demand specialized maintenance attention of as high a nature as that of Diesel-engine maintenance. In other words, it cannot be turned over to the ordinary steam-railroad repair shops without special supervision.

Undoubtedly, it has an advantage in the utilization of cheaper fuels than Diesel engines now require and the absence of lubricating oil.

In conclusion, I desire to know the approximate total weight of the Union Pacific unit and the available horsepowers expected.

I recently had an opportunity of riding on a Besler streamlined train operating between Bridgeport and Waterbury which uses a flash-boiler unit of substantially the same construction as that described in the paper under discussion. It is a 500-hp unit, supplying superheated steam of about 900 F with 1500-lb pressure to four engine units that are spring suspended on the driving axles of the truck. One high-pressure engine with variable cutoff discharges into a low-pressure one, and the exhaust from the latter is utilized in a high-speed turbine to run a cooling fan for the condenser on the roof.

This train ran with no vibration and, since it applies steam directly to the driving axle, would be more efficient than the turbine drive and electric transmission. Exhaust was perfect at all times.

To me, this comeback of steam is interesting, to say the least, and I expect it will act as a stimulus to oil-engine designers to produce a more elastic Diesel engine, through variable supercharging, and possibly supplanting the variable transmission between the prime mover and the traction wheels altogether.

HERMANN LEMP.[8]

TO THE EDITOR:

Although described as applicable to special and limited conditions, the development of the Steamotive gives promise of valuable contributions to the larger field of power-plant design. The features which are most interesting from this point of view are the forced circulation of the boiler with its associated steam separator and the exclusive use of forced draft.

Economic considerations probably will call for operating pressures much higher than the 1400 lb, which, for the past dozen years, has been regarded as the temporary pressure limit for general commercial application in this country. With the adoption of such higher pressures, control of circulation will assume greater importance and to have a local background of experience with forced-circulation boilers, even though of relatively small dimensions and capacity, will be of considerable advantage. These higher pressures will also bring an accentuation of the steam-separator problem, and experience with the Steamotive separator will, doubtless, throw light on this problem also.

Many practical obstacles are still ahead, but the simplification in draft equipment and in control facilities, as well as the saving in auxiliary power, make the exclusive use of forced draft, as adopted on the Steamotive, rather strongly attractive. Further advances in burner and furnace design and facilities for external cleaning of heat-absorbing surfaces should make such simplification a practical possibility.

The high combustion rate in relation to furnace volume, described by the authors, is, of course, of considerable interest. Practical considerations may prevent the attainment of equally high heat liberations in the case of the larger steam-generating unit burning solid fuel. However, some current designs for large capacity indicate trends in this general direction.

E. B. POWELL.[9]

[8] Consulting engineer, Ingersoll-Rand Co., New York, N. Y.

[9] Consulting engineer, Stone & Webster Engineering Corp., Boston, Mass. Mem. A.S.M.E.

TO THE EDITOR:

To discuss this paper I am going back some ten years and refer to the first commercial high-pressure boiler and turbine installed in the Edgar Station of The Edison Electric Illuminating Co. of Boston. The installation was successful from the start. It proved the advantage of using much higher steam pressure than was common practice at that time and, to a considerable extent, changed American and European engineering practice. However, English engineers are inclined to be rather conservative in regard to steam pressure yet are boldly increasing steam temperature. This interesting and perhaps startling innovation in steam-power practice, which utilizes high pressure and high temperature, was possible only by the cooperation of two leading manufacturers in the United States, the Babcock & Wilcox and General Electric companies.

Possibly, this Steamotive unit may be another important step in advancing the practice of converting the energy in the fuel into usable power. It is a most interesting, ingenious, and practical complete power plant. Its compactness is surprising, and no description can give an adequate idea of this feature, which must be seen to be appreciated. It must be realized that this is not a radical untried scheme. I have known of and watched its development for several years and know that every important part has been tested and operated under service conditions to insure its adequacy. After a number of units have been in regular commercial service for a time, some things not anticipated probably may show up, but they will undoubtedly be of a minor nature and can be easily corrected.

Such a compact unit, complete in every detail and utilizing high steam pressure and temperature, should be very attractive to the railroads of this country. It offers them a motive power for trains second to none available today. While the unit described is too small to be of use for the average central station, which needs units ranging from 35,000 to 200,000 kw capacity, a large field is available where it can be used with great advantage in improved efficiency, space saving, and lower labor costs. It is large enough to be useful to many electric systems, and its size can be increased to fill the central-station needs of many of the smaller utilities in this country.

I. E. MOULTROP.[10]

[10] Consulting Engineer, Belmont, Mass. Mem. A.S.M.E.

TO THE EDITOR:

The authors of this paper and the companies they represent are to be highly commended upon their conception and development of the Steamotive, which, from the results reported, is an efficient, lightweight, and compact steam-generating unit.

Full-automatic control is a major prerequisite for the effective operation of forced-circulation boilers when carrying a swinging load, due to the small quantity of saturated water in the system and to the absence of a fixed amount of superheating surface. The energy storage in the saturated water in the natural-circulation system and drums of the conventional type of boiler has an accumulator effect which damps the pressure fluctuations due to changing loads. This stabilizing action is less pronounced in the forced-circulation boiler, and controls must function rapidly to hold the pressure fluctuations within reasonable limits. The absence of a fixed amount of superheating surface necessitates automatic control of both pressure and temperature. Experience with a Bailey automatic-control system, installed in connection with the Purdue University forced-circulation steam generator, indicates that this type of control is reliable and functions satisfactorily and with sufficient rapidity to regulate the outlet pressure and temperature within practical limits on a swinging load.

The automatic features in connection with the burner are novel and add to dependability and safety.

The insertion of a separator between the boiler circuits and the superheater is advantageous in improving the cleanliness of the steam, in the maintenance of alkalinity and chemical balance required to prevent corrosion and scale formation, and in simplifying the control of the steam generator.

The multiplicity of furnace and boiler circuits contributes to efficiency.

The performance and efficiency of the Steamotive will be watched with interest by those concerned with the development of compact and efficient steam prime movers for railroad service and for other uses where space economy is a major consideration.

A. A. POTTER.[11]

TO THE EDITOR:

Perhaps the most interesting aspect of the development in steam generators described by Messrs. Bailey, Smith, and Dickey, is the fact that this unit, although not the product of a single organization, nevertheless is the product of a group of three organizations that have most closely coordinated their efforts. That coordination and the ability to obtain a complete unit from a single organization, or from a group acting as a unit, is most essential in any development of equipment suitable for providing comparatively small blocks of steam.

Like the Velox boiler, with which it has many points in parallel, from a standpoint of compactness and portability, Steamotive seems primarily to offer competition to the field heretofore considered as belonging exclusively to the Diesel engine. In railroad work, in particular, where the inherent disadvantages of the Diesel engine have been found to be particularly burdensome, Steamotive ought to find a natural outlet. From that standpoint, the two locomotives now being constructed for the Union Pacific will be watched by those interested in prime-mover development.

Overall efficiency of the unit is remarkably good for its size and pressure. That the principal auxiliaries are turbine-driven is interesting. This is a point that designers of larger power-system units have overlooked altogether too frequently in the past and that should be given more serious consideration.

The development of the Steamotive unit, like that of the Velox boiler, appears to be limited in its application, for the present at any rate, to oil or gas fuels. Of course, Steamotive does not have the same fundamental difficulties in burning pulverized solid fuels that the Velox boiler has, and some claims have been made that the unit can be used just as well on solid as on liquid fuels. Nevertheless, its performance with solid fuels has apparently not been explored and remains to be demonstrated.

Finally, the development of higher-pressure and temperature units in sizes suitable for use in industrial systems always raises the interesting speculation as to what effect it will have on power-supply economics and particularly power supply from central-station systems. To disregard or minimize the importance of a development of this sort would, of course, be folly but I should like to point out that, fundamentally, the sound economics of central-station supply are based on something more solid than mere differences in pressures and temperatures and portability or lack of portability of competing power supplies. For I take it as axiomatic that, by and large, no progressive power-supply group will lag behind any development in the more efficient generation of steam and power but rather, on the contrary, will, in the future, as in the past, lead and pave the way in those directions. That being so, to emphasize that the soundness of the economics of central-station power supply is due to half a dozen or so major factors which no developments of this kind should disturb is essential. Among these are the following:

(1) Ability to generate power in much larger units and the saving, therefore, of capital costs.

(2) Ability to use less spare capacity by virtue of the utilization of large numbers of units in a single station. Thus, for firmness of capacity, a station having six 40,000-kw units needs no more spare capacity than a station of two 40,000-kw units and requires 20 per cent spare capacity as against 100 per cent for a small isolated plant having a load of 2000, 3000, or 5000 kw.

(3) Interconnection of systems which makes possible the further reduction of reserve in a particular station and on a particular system. Interconnection offers many other economies too numerous to be dealt with extensively here.

(4) Smaller labor force and its more efficient utilization due to the use of larger units and greater attention to the one job with which the organization is concerned.

(5) Complete flexibility of a central-station supply program permitting the increase or decrease in the quantity of power as industrial processes change. With the swift pace of modern technology in almost all industries, this is particularly important.

(6) Definite realization that only a limited amount of capital and brain power is available to any particular organization and that better results will be obtained by concentrating these in the particular field specialized by the organization rather than to scatter them in a more or less foreign field.

All of these have been true for many decades and are bound to continue to be true for some time to come. But, the minute any particular group becomes so thoroughly convinced in the impregnability of its own ideas and methods as to assume an attitude of complacency, it is in line to receive a rude awakening. A development like this, if properly utilized to help keep power organizations on their toes, will assure that these awakenings, if any, will not be too rude.

PHILIP SPORN.[12]

[11] Dean of the School of Engineering, Purdue University, West Lafayette, Ind. Past-President, A.S.M.E.

[12] Vice-President and chief engineer, American Gas & Electric Co., New York, N. Y. Mem. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Mechanical Engineers' Handbook

KENT'S MECHANICAL ENGINEERS' HANDBOOK. Edited by Robert T. Kent. Eleventh edition. Vol. 2, on Power. Wiley's Engineering Handbook Series. Fabrikoid, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 1226 pp., $5. John Wiley & Sons, Inc., New York, N. Y.

REVIEWED BY ARTHUR M. GREENE, JR.[1]

TO those who were brought up with the early editions of Kent's Mechanical Engineers' Handbook, the engineer's "Bible" of those days, and who have used the later editions, the splitting of this book into at least three volumes indicates the advance of engineering practice in 42 years and, although some of us prefer our references within one set of covers, these advances seem to preclude that possibility.

In this separation into several volumes of Wiley's Engineering Handbook Series, some duplication of tables, and even of subjects, has occurred so that, in using the series, one will have to consult two books to determine which of the two gives the better treatment of a particular subject. As an example, in section 2 of Kent, on water, the division dealing with hydraulics gives merely a paragraph on critical velocity, compared with several pages in Vol. 1, of the series by Eshbach.[2]

In this same division of Kent, the relations between loss of head in pipes is given in a table with no reference to the effect of the Reynolds number on pipe loss, as brought out in Vol. 1. This same criticism may be applied regarding heat transfer. Although each volume gives excellent discussions of thermodynamics and cycles, one must turn to Vol. 2 by Kent when performance information regarding radiation of heat is required. The emissivity coefficients are found in Kent and not in Eshbach, although the latter deals with heat transmission in two of its sections.

This excellent volume of Kent's Handbook on power is well arranged in sections dealing with (1) air, (2) water, (3) heat, (4) combustion and fuels, (5) steam, (6) the steam boiler, (7) the steam engine, (8) the steam turbine, (9) condensing and cooling equipment, (10) refrigeration and ice making, (11) heating, ventilating, and air conditioning, (12) internal-combustion engines, (13) gas producers, (14) transportation, (15) electric power, (16) power test codes, and (17) mathematical tables. From these titles, the complete scope of the book is apparent, and when it is realized that various sections have been prepared by those who have given special study to their contributions, the value of the book is assured.

These sections contain descriptions of devices; experimental data on performance; and information regarding installation, operation, and maintenance, and methods of computation for design or for predicting and checking performance. The information is given concisely and clearly and, in most cases, the most recent practice is given, so that the engineer has available the great variety of specialized data to aid him in the solution of any problems relating to power.

In reviewing a handbook, one must, of course, look at the book as a mine in which technical data or methods of solving definite problems may be found for his use without reference to the many books, pamphlets, or papers in his library, which may be in another city. Hence, I have looked at this book for the things which I might want and which I know I can find scattered through my books. I have, therefore, examined this handbook to ascertain whether or not data of which I have knowledge are found in the sections. In the notes which follow, I have commented on the valuable features and also the omissions of the sections which were apparent to me.

Under the Properties of Air and Air Machinery, I find many of the data given were obtained more than a quarter of a century ago and no reference is made to the many results published by the National Advisory Committee on Aeronautics and the various aeronautic laboratories. No reference is made in this section under relative humidity to Carrier's work on relative humidity, although a reference is made in another section of the book. No reference is made to modern experiments on variation of the friction factor for flow with Reynolds' number or the work on bends in air piping carried out in many laboratories. As a result of the failure to use modern data, many of the tabular values are incorrect. It is regretted also that no data on windmills are included in this section or any other section.

The division on fans gives a number of curves in which the methods of rating are different, and nothing is stated regarding the basis of these ratings, so that use of the curves is difficult, and, in the tables, no reference is made to the best point of operation. No mention is made of the specific speed of fans and the manner of its use in fixing fan sizes, or of the fan law regarding the effect of density and the variation of various dimensions when the weight of discharged air is fixed. In fact, a full statement of the fan laws would be helpful and should be found in a handbook.

No mention is made, in the division on hydraulics, of the use of Reynolds' number, and, in the values of loss in tees, the percentage delivered to or from the branch and the run have not been indicated, and the values of K apparently refer to plugged fittings. The excellent work of Geisicke on divided circuits in tees has been neglected.

The division on hydraulic turbines is complete and contains modern data on design, construction, and operation of these prime movers. Selection of types, their peculiar features, and requirements to be met in their installation are covered, as well as the method of stepping up performance of a model to that of its full-size prototype. This division discusses cavitation, depth of draft tube, regulation, surge tanks, and pressure rise.

Much valuable information on steam pumps is presented, and this is followed by modern data on centrifugal pumps for all kinds of services.

The section on heat is divided into heat transmission, evaporators, driers and drying, heat insulation, and thermodynamics. Here, certain cross references should have been made, as, under specific heat of gas in one division, the average

[1] Dean, School of Engineering, Princeton University, Princeton, N. J. Fellow A.S.M.E.

[2] "Handbook of Engineering Fundamentals," edited by Ovid W. Eshbach. A review of this book appeared in MECHANICAL ENGINEERING, vol. 58, 1936, p. 852.

specific heats are given, while, in another division of the section, the correct expression for specific heat with its variation with temperature is given. The division on heat transfer is complete for apparatus in general, while each of the several divisions of the section deals with particular structures. This division recognizes only one method of finding the mean-temperature difference, and no reference is made to expressions for mean-temperature difference when the transfer coefficient varies with temperature. Table 2 of the conductances of vertical air spaces, derived in 1916, does not exactly check with the more recent conductances given by Rowley and Algren in 1929. Values of the curves of K for insulating material cannot be applied in the formulas given in this division as these values of K must be combined, according to Heilman, with an air-film coefficient, h, which is not constant.

Section 4 on combustion includes ample discussion of fuels and their properties and the requirements for their combustion as well as the proper heat release in combustion spaces, with the exception of the miscellaneous solid fuels; peat, sawdust, tanbark, straw, and bagasse. For these, practical suggestions regarding their combustion would be of aid.

The section on steam contains a discussion of the heat added by the boiler feed pump and the general cycles used with steam and binary fluids, while the third division correctly points out the part played by the viscosity of steam in its flow through pipes and proposes values of f in a simple formula depending on the Reynolds number, thus connecting this flow with that of other substances. This division contains factors for estimating losses in pipe fittings. The divisions on steam piping, stresses in pipe line, commercial pipe and tubing, pipe fittings, piping details, and steam values bring together, in close compass, the information for computation, layout, and specifications needed in steam-power work.

Section 6 on steam boilers covers types of boiler, boiler construction, superheaters, economizers and air preheaters, moisture in steam, boiler feeding, feedwater, boiler furnaces, and chimneys and draft, each with many data from modern practice, well-presented and well-selected. It is regretted that reference is made to the formula by Rankine and the more modern one by Kneass is omitted. In the excellent division on boiler furnaces, I find no reference in the index or text to the power requirement of various stokers, for pulverized-coal installations, or the quantity of coal handled by one pulverized-coal burner.

The steam-engine section is very complete, with discussion of the layout of cards for simple- and multiple-expansion engines, as well as the effects of the various elements of operation on efficiency. Valve gears receive proper treatment as well as the design of parts by empirical rules derived from practice in 1909. Of course, the more theoretical methods of the design of parts may appear in Vol. 2 of Kent.

Section 8 on the steam turbine includes descriptions of types and their cycles and nozzle, blade, and rotor designs, with a discussion of vibration and dynamic balance, and a very short statement regarding critical speed for which references to the complete study of this subject are given. The matters of turbine bearings, couplings, dummy pistons, labyrinth and water glands, and gears are followed by turbine lubrication and the proper oils. The question of the action of governors and their types includes those for control of bleeder, pressure, and throttle valves. Erection and operation data are of particular interest to the plant designer and operator, and the division on correction factors is of great value to those who wish to compare actual results with those under different operating conditions. The division on turbine performance is very complete, and it, as well as the engine section, is of great value to one who must select equipment, and the discussion of heat demands will aid him in laying out new cycles or analyzing those which are proposed for use.

The section on condensing and cooling equipment brings together, in small compass, the pertinent data needed in the study of such equipment.

Section 10 on refrigeration presents the data necessary for the solution of problems relating to demand and equipment for power-refrigeration, equipment and data for air machines, and compression and absorption machines for volatile fluids, piping, condensers, brine systems, and ice making.

The heating, ventilation, and air-conditioning section brings together, in logical order, the most recent constants used in computing the heat demands of a building to care for temperature difference, sun effect, and ventilating requirements, as well as the designs of the various systems of supplying the heat and ventilation demands. Apparatus, including the heat generators, is described. Air conditioning is the last division of this section and the computation necessary for the determination of size of equipment is explained by example, using experimental performance data of the manufacturers.

The section on internal-combustion engines has divisions devoted to Diesel, gas, and gasoline engines and contains descriptions of types, thermodynamics of the cycles, kinds of fuel, combustion-regulation factors affecting performance, and data regarding operation and maintenance.

Section 13 on gas producers discusses not only the chemical reactions in these structures but also presents data from operation including the economics, fuels, design, and maintenance. Utilization of producer gas is included with properties of these gases.

The section on transportation covers railroads, automotive vehicles, and aeronautics. The first division on railroads is quite complete regarding train resistance, locomotives, their design and performance, as well as braking, but it would be well if some information were given regarding the sizes and other characteristics of passenger cars and certain other freight cars. Divisions on automotive vehicles and aeronautics are complete with descriptions of parts as well as methods of parts design and tables of performance that give the data necessary for making computations to check proposals, make designs, or determine preliminary estimates.

The electric-power section covers purchased power, generated power, conversion equipment, switchboard equipment, batteries, power factor, and power distribution. In each division, tables or curves of constants, properties, or performance, together with descriptions of apparatus and circuit diagrams with formulas, give information needed by the engineer to design or check equipment necessary in electric-power work.

Twelve of the A.S.M.E. Power Test Codes, as well as instructions regarding instruments and apparatus, are found in Section 16. This makes available, in one desk book, this useful information.

The book closes with an excellent set of mathematical tables, which were probably thought necessary by the editorial board to make the book self-contained, but, unfortunately, some desirable mathematical tables are not in this volume, but are found, in Vol. 1 of the series, thus requiring the use of that volume when needed.

Typography of the book is excellent, and the increased number of pages in the several volumes has permitted addition of many details that were not included in the earlier edition. Each section has been reviewed by a number of specialists so that the authoritative nature of the treatment maintains the standard set many years ago by William Kent.

The Collected Papers of Rhys Jenkins

THE COLLECTED PAPERS OF RHYS JENKINS. Links in the History of Engineering and Technology from Tudor Times. Printed for the Newcomen Society at the University Press, Cambridge, 1936. Cloth, 11 × 8½ in., 248 pp., 8 plates, 26 figs.

ENGINEERING history owes much to Rhys Jenkins. For more than 40 years this former senior examiner of the British Patent office has been exercising his historical sense and knowledge of technology in exploring sources in manuscript, printed page, and historical relic and archive in the painstaking task of evaluating and interpreting the works of engineers of former generations and the development of engineering and the industrial arts. A monumental task, which he shared with H. W. Dickinson, is well known to engineers in the memorial volume, "James Watt and the Steam Engine," prepared for the committee of the Watt Centenary. Commemoration at Birmingham 1919, and published in 1927. Other volumes, "Power Locomotive on the Highway" (1896) and "Motor Cars and the Application of Mechanical Power to Road Vehicles" (1902), with a host of briefer contributions to engineering periodicals and historical societies have earned for him an honored place among the biographers and historians of technology, so brilliantly brought to the attention of the public by such a writer as Samuel Smiles.

As its title implies, the volume under review comprises some 25 articles of varying length reprinted from the magazines in which they originally appeared over a period of more than 40 years and covers a wide range of subjects. The essays are conveniently grouped under the general topics of mechanical technology, steam engineering and foundry work, hydraulic and sanitary engineering, and industrial and economic history. To these there are conveniently appended a list of the author's published works, a list of authorities quoted, and a general index. The papers are devoted to such diverse subjects as biographical sketches of Thomas Savery and Thomas Newcomen, a water closet of the sixteenth century, and the protection of inventions during the Commonwealth and the Restoration. The illustrations range from photographs of historical relics to reproductions of the original sketches and notebooks of early inventors. The quaint phraseology and amazing spellings of sixteenth-century engineers and chancery clerks are sprinkled amid Mr. Jenkins' easy-flowing English to add verisimilitude to the record and to draw the reader back into the era that antedated the Industrial Revolution. As he passes from one paper to another the reader is impressed with the thoroughness with which the author has investigated his source material, and with which he has checked and weighed the evidence that has come to his attention and the opinions expressed by others. The reader is impressed too with the courage, ingenuity, and persistence of the pioneer engineers who worked without benefit of a sound knowledge of the basic sciences on which their inventions rested, with imperfect and ill-suited materials, and with inadequate and crude tools and methods. He senses the oddly assorted characteristics these men displayed, their jealousies and rivalries, their vaunting hopes, the frustration of their cherished dreams, their difficulties and disappointments with financial backers and patrons, their troubles with the patent office, and their attempts to secure monopolies and preferment.

To an engineer on this side of the Atlantic who must look to England for the background of his language, his law, his traditions, and his culture, a reading of these papers adds convincing evidence of another debt for his technology and his engineering. For while many of the developments about which Mr. Jenkins writes were going on, this country was being won from the forest and plain, and the arts of the mechanic were the commonplaces of handicrafts. Thus these "links from Tudor times" bind us also to a common heritage of technology.

It would be difficult to say which of the individual papers makes the most enjoyable and profitable reading, for every reader will have his own background of technical and industrial interest against which to assess his preferences. This reviewer confesses to a special liking for the paper on the slitting mill, for the group dealing with the history of the steam engine, with its biographical sketches of Savery and Newcomen, and for another group on pumps and water works. He also admits that he studied all of the contemporary drawings with care and some perplexity, that he read all the quotations from old records and documents for the pleasure found in their quaint style, and that he learned that lawyers have ample precedent for interminable and confusing sentences. Furthermore, having read with explosive guffaws the description of the sixteenth-century water closet, he is more than ever willing to defend the thesis that advance of civilization follows development of plumbing.—G. A. S.

Books Received in Library

AMERICAN SOCIETY FOR TESTING MATERIALS. INDEX TO PROCEEDINGS, vols. 31–35 (1931–1935). American Society for Testing Materials, Philadelphia, 1937. Half leather and cloth, 6 × 9 in., 194 pp., $2.25; $3. This volume contains author and subject indexes for the Proceedings of 1931–1935 and of the symposiums presented at regional, local, and annual meetings, and not published in the Proceedings.

AUSFÜHRUNG VON ANSTRICHEN. (Merkbücher der Anstrichtechnik, Heft 3/4.) By R. Klose. V.D.I. Verlag, Berlin, 1937. Paper, 4 × 6 in., 49 pp., illus., diagrams, charts, tables, 1.25 rm. A brief manual on varnishing and lacquering heavy and light metals and wood. Methods of preparing the surface and of applying the lacquer by brushing, dipping, and spraying are described in a practical way.

AUTOMOBILE ENGINES. (Motor Manuals, vol. 1.) By A. W. Judge. Third revised edition. Chapman & Hall, London, 1937. Cloth, 5 × 8 in., 301 pp., illus., diagrams, charts, tables, 5s. This is volume 1 of a British series of four "Motor Manuals" intended for the elementary reader. In this volume are found combustion theory, parts and types of automobile engines, supercharged, two-cycle, and compression-ignition engines, lubrication, cooling, and testing practice. Such metallurgical and chemical information is included as is necessary to explain certain basic principles or recently developed materials.

BETRIEBSTECHNISCHE SAMMELMAPPE, Die gesammelten und überarbeiteten Blätter des Betriebsarchivs aus den letzten Jahrgängen der Zeitschrift "Maschinenbau/Der Betrieb." V.D.I. Verlag, Berlin, 1937. Paper, 9 × 12 in., 52 Betriebsblätter, illus., diagrams, charts, tables, 6 rm. Since 1933 a series of charts has been regularly published as a supplement to "Maschinenbau: Der Betrieb," which forms a valuable storehouse of numerical and practical information upon factory problems. These charts have now been collected and published in a loose-leaf binder. The charts cover a wide range of subjects, including the choice of motors, belt design, tool dressing, carbide tools, stamping and turning, welding, heat-treatment, surface treatment, etc.

COMPENSATING INDUSTRIAL EFFORT. By Z. C. Dickinson. Ronald Press Co., New York, 1937. Cloth, 6 × 9 in., 479 pp., charts, diagrams, tables, $4.50. A study of the problem of work incentives. The discussion covers the causes determining the amount of wages of occupations and individuals, the relative efficacy of various stimuli and factors in increasing production, and the social consequences of various work-and-pay situations. The subject is considered from the economic and psychological viewpoints, as well as from that of industrial management.

DIESEL ENGINE DESIGN. By H. F. P. Purday. Fourth edition. D. Van Nostrand Co., New York, 1937. Cloth, 6 × 9 in., 520 pp., illus., diagrams, charts, tables, $8. In this new edition the principal idea is to present the functions and details of various types of Diesel engines side by side, emphasizing the fundamental design problems. The revision has taken into account the rapid developments of the last decade. New chapters have been added on mechanical efficiency, balancing, vibration, noise, lubrication, and supercharg-

ing. Sectional and outside views of representative engine types are shown.

DIESEL HAND BOOK. Fourth edition. By J. Rosbloom. Diesel Engineering Institute, Jersey City, 1937. Leather, 5 × 7 in., 719 pp., illus., diagrams, charts, tables, $5. The material in this handbook is divided into two parts. Part 1 contains information on heat, power, liquids, and metals used in connection with Diesel engines, and compressor theory. Part 2 covers theory and practice of all types of Diesel engineering, land, marine, locomotive, aero, automotive, and portable installations.

GASOLINE AGE, the Story of the Men Who Made It. By C. B. Glasscock. Bobbs-Merrill Co., New York and Indianapolis, 1937. Cloth, 6 × 9 in., 359 pp., illus., $3. An historical account of the rise of the automobile told mainly through the medium of the men who were the moving lights in the industry. The information is biographical, statistical, and financial, not technical. At the end of the book is a list of all makes of cars ever produced in the United States.

GASTAFELN, Physikalische, thermodynamische und brenntechnische Eigenschaften der Gase und sonstigen Brennstoffe. (Sonderdruck aus "Handbuch der Gasindustrie," Bd. 6.) By H. Brückner. R. Oldenbourg, Munich and Berlin, 1937. Cloth, 7 × 10 in., 152 pp., diagrams, charts, tables, 12 rm. The aim of this work is to present all the numerical data needed by the gas engineer, in one convenient volume. The physical and thermodynamic properties of gases and their properties as fuels are discussed and tabulated.

THIS MONTH'S AUTHORS *and* PAPERS

DECENTRALIZATION, in the opinion of W. J. CAMERON, should not be looked upon as repairing an error in judgment but rather as a logical development of industrial experience. Branch factories, according to the paper, "Decentralization of Industry," are not an example of decentralization, which really starts where the branch-factory movement terminates. From the employee's angle, this arrangement has the advantages of small factories, where noise and strain are minimized, combined with living quarters in or adjacent to an American village, while equally definite advantages accrue to the industry.

The author, who is widely known as the commentator on the radio program sponsored by the Ford Motor Company, was educated in the public schools of Jackson, Mich. He was first employed in the Michigan Central's local shops as timekeeper and, in his teens, had charge of the bookstand in its Detroit station. Mr. Cameron subsequently became correspondent, reporter, editorial writer, and columnist for *The Detroit News*. In 1919, he went with the Ford Motor Company and, while *The Dearborn Independent* was published by that company, was the editor.

AUTOMOTIVE INDUSTRY'S CONTRIBUTIONS

After some generalizations regarding the automotive industry, C. F. HIRSHFELD comments on some specific contributions that it has made to other industries, such as advances in metallurgy and foundry practice, development of intrafactory transportation, interchangeable parts, standardization, and procurement and scheduling. His paper, "Automotive Contributions to Other Industries," discusses the economic and social significances of that industry and points out the effect of mass production and mechanization, not only upon the automotive industry but also upon other industries that depend upon it as an outlet for their products and services. In this connection, Mr. Hirshfeld states that the 450,000 individuals engaged in the production of automobiles in 1929 provided employment for almost 5,000,000 individuals in other industries and that, while the population of the United States increased only 62 per cent between 1901 and 1930, mechanization, which enabled one worker to produce more real wealth per hour of toil, was responsible for an increase of over 400 per cent in our national income in the same period.

The author, who is well known to engineers as chief of the research department of The Detroit Edison Company for nearly a quarter century, an active member of the A.S.M.E. since 1905 and a manager and a vice-president, and the first chairman of the Engineers' Council for Professional Development, was educated at the University of California and Cornell University. He taught at the latter institution for 11 years and resigned the professorship of mechanical engineering to accept his present position with the Detroit Edison Company. He has written or collaborated in the preparation of a number of books and is the author of papers and articles on technical subjects, some of which have appeared in A.S.M.E. Transactions and in MECHANICAL ENGINEERING.

CONTROL METHODS IN THE AUTOMOBILE INDUSTRY

Some of the problems confronting management in the automobile industry and methods of handling them are discussed by J. W. SCOVILLE. Although certain economists criticize the pricing policies of the industry, stating that prices are not competitive, the paper "Methods of Control in the Automobile Industry" points out that motor-vehicle building is highly competitive and no producer has the power that comes from monopolistic control, citing the decrease in the number of automobile companies from 93 in 1922 to 24 in 1937 and the fact that the largest manufacturer produced only 43 per cent of the cars sold in 1936. Effects of seasons and new models upon consumer demand and the efforts made to stabilize output by study of reports from dealers and former production records are commented upon, the statement being made in this connection that few, if any, industries can compare with the automotive in the wealth of exact and timely information on consumer demand which is available to the executives.

Mr. Scoville was graduated from Syracuse University in 1901 with the degree of B.A. and taught mathematics in various high schools at Syracuse, N. Y., and also for two years in New York, N. Y. His business career began as chief statistician for the American Writing Paper Company. In 1921, he organized the statistical department of the Maxwell Motor Corporation which had been incorporated to succeed the old Maxwell company. With the formation of the Chrysler Corporation in 1925 to take over the Maxwell and Chalmers companies, Mr. Scoville became its chief accountant, a position that he still holds.

RESEARCH ON FLOW NOZZLES

Differences in forms of flow nozzles proposed by A.S.M.E. Power Test Codes Committee, Compressed Air Society, and I.S.A. led to formation of a committee to study the subject of fluid measurements and inauguration of a research program under the auspices of the A.S.M.E. Special Research Committee on Fluid Meters. Steps leading to the start of the research and progress made thus far in conducting tests are told in a contribution entitled "Research on Flow Nozzles by Fluid Meters Committee," by H. S. BEAN, who is in charge of the research.

The author, who is a member of A.S.M.E., has been associated with the National Bureau of Standards for approximately 20 years and has held his present position, chief of the gas measuring instruments section, for almost 17 of these. In addition to his work in connection with the flow-nozzle research, Mr. Bean has served as the Bureau's observer on researches and tests conducted by American Gas Association and the Natural Gas Association of America from 1924–1929 and has written several papers relating to the measurement of gas by orifice meters.

MASS PRODUCTION AND STANDARDS OF LIVING

Mass production is not something new; it goes back to the time when man first discovered that individual productivity could be multiplied by harnessing animals. The paper by W. T. CHEVALIER, "Multiplying Our Productivity," traces the idea's growth from this small beginning through the discovery and application to machines of the expansive power of steam to the most outstanding example of today, the automotive industry which, directly or indirectly, provides work for one out of every seven persons gainfully employed in the United States.

While pursuing his studies at the Polytechnic Institute of Brooklyn, the author was engaged in the design and construction of high-tension electric conduits and accessory structures for the Consolidated Telegraph and Electrical Subway Company, New York, N. Y. From 1910 to 1917, he was employed on various construction and development projects in and around New York and the application of bituminous compositions in waterproofing and anticorrosion work. After two years' service

in the World War, Mr. Chevalier returned to the American Bitumastic Enamels Company as general manager until 1921. A brief period as consultant on technical advertising and promotion work followed before he joined the staff of *Engineering News-Record* as associate editor. Mr. Chevalier was business manager of that periodical from 1923 to 1927 and has been publishing director of the civil-engineering and construction publications of the McGraw-Hill Publishing Company since November, 1927. For the last three years, he has been vice-president of the company in charge of its civil engineering, construction, and mining publications. Mr. Chevalier is a member of numerous technical and industrial associations, including the American Society of Civil Engineers, of which he was a director from 1925 to 1927; American Water Works Association, receiving its John M. Goodell Prize in 1934 for his paper, "The Place of Public Works in the Economic Scheme;" and the American Road Builders Association, having served as its president since 1936. In addition to the C.E. degree that was conferred upon him by the Polytechnic Institute of Brooklyn when he was graduated in 1910, the Colorado School of Mines, Golden, Colo., made Mr. Chevalier an Honorary Doctor of Engineering in 1936.

THE CENTURY'S GREAT INVENTIONS

The recently retired dean of engineering at Cornell University, who served an apprenticeship with Pope and Talbot, Port Gamble, Wash., and the Union Works, San Francisco, Calif., before he was graduated from Leland Stanford University in 1896. Fruitful experiences at the Union Iron Works and later as designing engineer for the Anaconda Mining Company acquainted him in the design and construction of some of the finest machinery the times produced and laid the foundation for his long and brilliant career as a teacher of engineering. Later, as works manager of the Stanley Electric Manufacturing Company, Pittsfield, Mass., his natural qualities of leadership underwent the refinement of application to industrial realities. Here he gained first-hand knowledge which lent authority and common sense to his later teachings in this field. As president of The American Society of Mechanical Engineers he traveled extensively and spoke frequently in behalf of the Society. His springy step, sparkling eye, keen sense of humor, wise counsel, and sound judgment have endeared him to several generations of engineers throughout the country. He has touched life at so many points and read history with so keen an understanding that he remains an optimist.

Last November, when the United States Patent Office celebrated its centennial with appropriate exercises, DEXTER S. KIMBALL was asked to prepare the address "The Century's Great Inventions" which appears in this issue. The task was not an easy one but Dean Kimball, starting with the three great inventions which ushered in the Industrial Revolution—the spinning jenny, the steam engine, and the screw-cutting lathe—succeeded in making a general classification under eight headings with which few will be inclined to quarrel.

HIGH-SPEED TRANSPORTATION

Not the least of the problems of high-speed transportation is the provision of dependable means for stopping trains when necessary, and hence manufacturers of braking equipment have had to keep pace with designers of modern railway equipment if the new schedules are to be met with safety to the traveling public. As a railroad man and vice-president of the New York Air Brake Company, L. K. SILLCOX has given much thought to a study of high-speed trains and their equipment, and in his paper "How Fast Is Too Slow?" he comments upon certain phases of this timely subject.

Mr. Sillcox is well known to members of The American Society of Mechanical Engineers for his many years of service on some of its committees. His professional career, which started on the New York Central following his graduation from the École Polytechnique of Brussels, Belgium, has been in railroad equipment and railroad shops in this country and in Canada. A member of a score of technical and scientific societies, Mr. Sillcox has given unstintingly of his services to these groups. He writes and lectures extensively, being a lecturer on railway practice at the Harvard School of Business Administration. This month's article was presented not only to the Washington, D. C., section of the A.S.M.E. but also at New York University. Mr. Sillcox is a widely read student of industrial and transportation history and has one of the finest private collections of books on these subjects in the country.

MEN, MANAGEMENT, AND THE FUTURE

Management in the future will be more difficult than it has been in the past. This is due, in part, to the fact that formerly management attempted to dominate labor, achieving some measure of success but also arousing a spirit of retaliation; also because it can succeed only by interweaving of interests; and, more especially, because the leadership of labor has stepped out of its proper place in the capital-customer-labor equilateral triangle and has not learned that survival value comes from intelligent group cooperation.

F. A. MAGOUN, author of "Men, Management, and the Future," was graduated from Massachusetts Institute of Technology in 1918 with the degree of B.S. After a year in industry and a similar period at the Lowell Textile School teaching applied mechanics, he returned to his alma mater in 1920 as instructor in naval architecture and was promoted, in 1930, to associate professor of humanics. Professor Magoun is a member of the Society for the Promotion of Engineering Education and the author and editor of a number of books on engineering and aeronautics.

A FAMOUS MACHINE-TOOL BUILDER

When he was engaged in teaching mechanical-engineering subjects at Yale University, J. W. ROE became interested in certain phases of industrial history and biography which led to a now famous work "Early English and American Tool Builders." One of the features of this book was the series of "industrial geneologies" by which it was shown how the machine-tool establishments of this country were interrelated through their founders' connections with the firms for which they previously worked. Now, in the story of the life of one of the country's well-known machine-tool builders, Professor Roe has developed in greater detail the biography of James Hartness, past-president and honorary member of The American Society of Mechanical Engineers. Professor Roe's contribution to this issue is taken from one of the chapters of the biography of James Hartness just published as one of the series of biographies sponsored by The American Society of Mechanical Engineers.

Professor Roe is known among his friends as an accomplished raconteur and brilliant conversationalist, with a wealth of interesting anecdotes and well-authenticated information on industrial history. Most of his life has been spent in teaching at Yale and at New York University. Retired early in 1937, Professor Roe plans to conduct a few courses at Yale next year, and it is the hope of his friends that in the leisure of his beautiful colonial home at Southport, Conn., he will find the time and inclination not only to engage in sketching and painting but also to add to the literature of industrial history.

LABOR PROBLEMS

W. RUPERT MACLAURIN, author of this month's economic review, "Labor Problems," is assistant professor in the department of economics and social science at Massachusetts Institute of Technology. He is a graduate of Harvard University, holding the degrees of A.B., M.B.A., and D.C.S.

THE AMERICAN ENGINEERING COUNCIL

It is not easy for the individual member of the engineering societies that participate in the American Engineering Council to retain a comprehensive knowledge of the numerous purposes and achievements of that "organization of organizations," because his contacts are usually through another body instead of being direct and personal. For this reason the brief résumé of the work of the Council that A. A. POTTER presented at the Detroit Meeting of The American Society of Mechanical Engineers should be unusually helpful. Dean Potter is serving his second year as president of the American Engineering Council and is devoting his time and enthusiasm to it with his characteristic energy and vigor.

Dean Potter's name is well-known wherever engineering research is known; but members of The American Society of Mechanical Engineers think of him most gratefully as one of their illustrious past-presidents. When the breadth and number of Dean Potter's interests and services are considered there is cause for wonder that he can be so well-known to the undergraduates at Purdue as to occupy the position of affection with them that he unmistakably does. For the warmth and genuineness of his human sympathies and the keenness of his understanding have placed him high in the roll of those who exert benign and lasting influences on college students. Few men have time and energy to do as many things as Dean Potter does, and to do them as well.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

Detroit Is Host to A.S.M.E.

High Lights of the 1937 Semi-Annual Meeting Held May 17 to 21

AFTER months of careful planning by local committees, professional divisions, and the Committee on Meetings and Program, the 1937 Semi-Annual Meeting of The American Society of Mechanical Engineers, at Detroit, Mich., opened at the Hotel Statler headquarters on Monday, May 17, preceded by a meeting of the Executive Committee of the Council on Sunday, and closed on Friday, May 21, with technical sessions, and plant-inspection trips, leaving in the minds of the 1105 who registered pleasant memories of an interesting and fruitful week.

General Sessions Greatly Appreciated

A unique plan, conceived nearly a year ago by those in charge of the meeting, worked out admirably. With Society business out of the way by Monday night the remaining days were devoted to a series of general sessions built up on the contributions of the automobile industry to mechanical engineering. No counter attraction in the way of technical sessions held simultaneously with these general sessions diverted members from participation in them. Mornings and evenings were given over to these general sessions, leaving the afternoons for simultaneous sessions sponsored by the Society's professional divisions and committees, and for plant-inspection trips for which the Detroit area offered unusual opportunities. To suit the convenience of members and guests, visits to The Detroit Edison Company and the Ford Motor Company were arranged for Monday and Friday, with an additional visit on Friday morning to the Great Lakes Steel Corporation.

Opportunity was also afforded for a brief business meeting of the Society on Monday night and for meetings of numerous technical and other committees, reports of which will be found in these pages. The Nominating Committee was in session and the officers nominated by it, with brief biographical sketches of all candidates, will be found on pages 555 to 559 of this issue.

Social Events Add to Enjoyment

Informal get-togethers, following the evening sessions, provided opportunities for social contacts. The dinner on Thursday evening, at which more than six hundred were present, brought men and women together to witness the conferring of honorary membership in the Society on Alex Dow and the presentation of the Holley Medal to Henry Ford. A special program for the women provided abundant entertainment and opportunity for sight seeing.

Nor was the A.S.M.E. alone represented, for, in accordance with an established custom of cooperation with other engineering groups, the participation of the American Society of Tool Engineers, the American Welding Society, the Society of Automotive Engineers, and the Engineering Society of Detroit aided materially in technical and general sessions. Invitations to the Engineering Institute of Canada and the Cleveland Engineering Society resulted in the attendance of members of these sister societies at sessions and on inspection trips. Such nearby institutions as the University of Michigan, the University of Detroit, and the Michigan State College sent delegations of student members to the meeting and the dinner and provided assistance in the conduct of sessions.

Detroit Industries Attract Visitors

While it is impossible in this brief account to describe the well-conducted inspection trips, mention of the places formally visited will testify to the variety and interest of the opportunities afforded visitors to Detroit. The Detroit Edison Company provided opportunity to see the rebuilt Conners Creek plant of its system. At the invitation of the Ford Motor Company the Edison Institute Museum and Greenfield Village were visited, and the manufacture of automobiles was witnessed at the Rouge plant, where the principal points of interest were the 325,000-kw power plant, the Ford steel mill, the Ford final-assembly line, the glass plant, and the Rotunda moved to Dearborn in 1935 from the Chicago Century of Progress Exposition which members of the Society had an opportunity to

HENRY FORD RECEIVES HOLLEY MEDAL FROM PRESIDENT HERRON WHILE PAST-PRESIDENT ALEX DOW LOOKS ON

GUESTS AT SPEAKERS' TABLE ASSEMBLED BEFORE THE DINNER

(Left to right: Harvey N. Davis, James M. Todd, Paul Doty, Henry Ford, James H. Herron, Alex Dow, W. T. Chevalier, H. T. Woolson, F. M. Feiker, R. L. Sackett, and C. E. Davies.)

visit in connection with the 1932 Semi-Annual Meeting.

Following a paper by William C. Rudd and Bernard J. Mullen on Tuesday afternoon, the Springwells pumping station of the Detroit Department of Water Supply was visited. An alternative visit to the Champion Spark Plug Company was also made on Tuesday afternoon.

On Wednesday and Thursday afternoons opportunity of studying production methods in the automotive and related industries was afforded in visits to the Plymouth Motor Corporation, the Chevrolet Forge Plant, the Ex-Cell-O Aircraft and Tool Corporation, Dodge Bros. Corporation, and the United States Rubber Company.

Two papers at the general session on Thursday morning on the subject of steel and its application, under the auspices of the A.S.M.E. Iron and Steel Division, presented by T. F. Olt, of the research laboratories of The American Rolling Mill Company, and J. E. Angle, assistant general superintendent of tin mills, Chicago District, and W. F. McGarrity, strip metallurgist, metallurgical department, Pittsburgh District, Carnegie-Illinois Steel Corporation, put members and guests in a receptive frame of mind for the visit, on Friday morning, to the Great Lakes Steel Corporation, where hot- and cold-rolled strip steel up to 90 in. wide is rolled.

Women Have a Fine Time

Entertainment features for the women were admirably handled by an efficient and cordially hospitable committee that had headquarters in the Hotel Statler. On Monday a special tour of the Ford Rouge plant and Rotunda was followed by an evening's entertainment at the studios of radio station WWJ. Tuesday was given over to a visit to the Edison Institute Museum, luncheon at Dearborn Inn, and a trip through Greenfield Village.

An opportunity for sight seeing was provided on Wednesday with a drive through the suburban districts of Detroit to the Oakland Hills Country Club, where luncheon was served, after which the Cranbrook Foundation, noted for its architecture and landscaping, was visited.

An automobile drive through Detroit's residential district to Grosse Point, Lake St. Clair Shores, and return to Belle Isle occupied Thursday morning, after which luncheon was served at the Detroit Yacht Club and a bridge party enjoyed.

General Sessions in Brief

Undoubtedly the outstanding feature of the Detroit meeting in so far as papers of interest to all were concerned was the program of general sessions already mentioned. The sessions provided an opportunity for every one to attend. The three evening sessions, one of which was the dinner, made it possible for persons otherwise kept away by pressure of regular duties to take part in the meeting. James H. Herron, president of the Society, presided at the opening of all of these sessions and acted as toastmaster at the dinner. Following a gracious and dignified introduction, Mr. Herron turned over every session to a presiding officer who introduced the speakers and conducted the discussion.

At the opening session on Tuesday morning, John H. Hunt, president of the Engineering Society of Detroit, presided. The keynote address by C. F. Hirshfeld set a high tone to this general session. Mr. Hirshfeld's paper, which will be found on pages 488 to 492 of this issue, described the scope and purpose of the planned program for the general sessions and presented a historical sketch in which were contrasted the practice of automotive design and production with methods in other engineering fields. Mr. Hirshfeld paid high tribute to the automotive industry and its qualities of courage and resourcefulness. There followed a paper, contributed by the Railroad Division, sponsors of the session, on Modern Locomotive and Axle-Testing Equipment, in which the authors, T. V. Buckwalter, vice-president, W. C. Sanders, general manager of the railway division, and O. J. Horger, research engineer, all of the Timken Roller Bearing Company, described tests and testing equipment of their company.

Improved methods of fabrication was the subject of the second general session, held Tuesday evening, under the joint auspices of the American Society of Tool Engineers, and the A.S.M.E. Machine Shop Practice Division. W. L. Batt, past-president, A.S.M.E., presided. In the absence because of pressure of urgent business of W. S. Knudsen, president, General Motors Corporation, who had been scheduled to present a paper on "Recent Developments in Basic Processes of Fabrication, With Social and Economic Implications," Charles F. Kettering, vice-president in charge of research of the General Motors Corporation, spoke informally on the subject "A Research Engineer Looks at Research," and stimulated his audience with characteristic utterances of paradoxical and amusing observations. By using everyday examples, Mr. Kettering showed how little is known of the basic phenomena in physics and chemistry, emphasizing that most of our present-day knowledge is

how things behave rather than *why* they behave as they do.

Mr. Kettering was followed by Fred W. Cederleaf, manager of the machinery division of the Ex-Cell-O Aircraft and Tool Corporation, whose paper, "Machine-Tool Builders' Contributions to Mass Production of Automobiles," appeared in the June, 1937, issue of MECHANICAL ENGINEERING.

The A.S.M.E. Railroad Division sponsored the third general session, held Wednesday morning, on lightweight high-speed trains. W. H. Winterrowd, of the Railroad Division, presided. A stimulating address on "Automotive Engineering Applied to Railroading," which held the attention of an appreciative audience, was delivered by E. G. Budd, president of the Edward G. Budd Manufacturing Company. Mr. Budd's address will be found in the June issue of MECHANICAL ENGINEERING.

Because Rupen Eksergian was in Philadelphia receiving the Henderson Medal for his contributions to railroad engineering, his paper on "The Economics of Power for Lightweight Trains," which followed Mr. Budd's address, was presented in abstract by his brother, C. L. Eksergian. Mr. Eksergian's paper will be published in a later issue of the Transactions of the Society.

The fourth general session, held on Wednesday evening and devoted to the general subject of management and mass-production methods, was under the joint auspices of the Society of Automotive Engineers and the A.S.M.E. Management Division. K. T. Keller, president of the Chrysler Corporation, presided. Two thoroughly enjoyable addresses, both of which will be found elsewhere in this issue (pages 493 to 499 and 483 to 487), were delivered respectively by John W. Scoville, chief statistician, Chrysler Corporation, and W. J. Cameron, of the Ford Motor Company. Mr. Scoville's address was a brilliant and entertaining exposition, profusely illustrated, entitled "Methods of Control in the Automobile Industry," and was an excellent example of the possibility of making statistics alive and interesting. W. J. Cameron, nationally known for his profound radio talks filled with sound philosophy that add such thoughtful substance to the "Ford Sunday Evening Hour," explained Mr. Ford's ideas on "Decentralization of Industry."

Thursday morning's general session, fifth of the series, on "Steel and Its Applications," was conducted under the auspices of the A.S.M.E. Iron and Steel Division. J. A. Clauss, chief engineer, of the Great Lakes Steel Corporation, presided, and prefaced his introduction of the speakers with a brief résumé of the development of the steel industry in Michigan. The two papers covered complementary aspects of strip-mill practice. T. F. Olt's paper was entitled "Production and Quality Control of Sheets for Automobile-Body Fabrication," and is to be found in the A.S.M.E. Transactions for April, 1937, pages 185 to 195. The second paper was prepared by J. E. Angle and W. F. McGarrity, respectively, assistant general superintendent, sheet and tin mills, Chicago District, and strip metallurgist, metallurgical department, Pittsburgh District Carnegie-Illinois Steel Corporation. This paper will be published in the July issue of the A.S.M.E. Transactions.

FACSIMILE OF AUTOGRAPHED DINNER MENU

The Dinner Is Colorful

On Thursday evening more than 600 members and guests with a gratifyingly high percentage of ladies assembled for dinner in honor of Henry Ford and Alex Dow. The dinner also served as the concluding general session, with a stirring address, masterfully delivered, by Williard T. Chevalier, vice-president, McGraw-Hill Publishing Company.

Seated at the speakers' table were James H. Herron, president, The American Society of Mechanical Engineers, toastmaster; Alex Dow, past-president and honorary member of the Society; Henry Ford, Holley medalist; Williard T. Chevalier, speaker of the evening, Roy V. Wright and Paul Doty, past-presidents, A.S.M.E.; Harry T. Woolson, president, Society of Automotive Engineers, F. M. Feiker, executive secretary, American Engineering Council; R. L. Sackett, R. J. S. Pigott, and James M. Todd, vice-presidents, A.S.M.E.; L. T. Knocke, chairman, Detroit Section, A.S.M.E.; Harvey N. Davis, chairman, Meetings and Program Committee, A.S.M.E.; and C. E. Davies, secretary, A.S.M.E. All were introduced by President Herron. The program of the dinner bore the reminder that May 20 was the tenth anniversary of the first New York to Paris flight by Col. Charles A. Lindbergh, completed successfully on May 21, 1927.

Mr. Herron opened the after-dinner exercises by announcing the registration (911 at that time) and complimenting all those who had labored to make the meeting a success. He said in part:

I think that there is hardly a program that we have had in connection with a semi-annual meeting of the Society that has been as comprehensive as the program we have had here in Detroit this week. It has covered the field of production, the field of production control, and all of those other matters which tend to make our lives more comfortable and give us the opportunity to realize a little more abundant life.

I was particularly interested in not only centralization of industry as we have exemplified it in Detroit and covered it in our programs, but also, the decentralization which Mr. Ford is accomplishing in connection with certain small units of production. The centralized production possibly gives as much to the material benefit in the working class as the decentralized portion, but we find that something is added in decentralizing industry. It is well worth-while. It seems to satisfy the spiritual as well as the material needs. I understand that the production under such conditions is no more costly than under centralized conditions. This seems hardly possible; however, the demonstration has been made.

In connection with the immense production in the Detroit field we find the finger of demand reaching out into all classes of materials. When we consider the fact that all materials are originally labor, or nearly so, while the element of greater production, mechanically applied, will decrease labor in one place and increase labor in other places, we have an adjustment with no loss in total labor. The use of the materials entering into the automobile and the immense production extends into all classes of material manufacture. Let us consider steel, for example, and the tremendous development in the manufacture of sheets for automobile production. I will not undertake to quote figures, but when we consider the continuous-strip mill versus the old hand mill on sheet pro-

duction, the result is astounding, and we can hardly conceive of the additional production. Moreover, the demand created in this production program has stimulated the development in the steel-manufacturing business, and extends into rubber, fabrics of various sorts, enamels, and the synthetic lacquers, of which so many are being used at this time.

So the production program about which we have learned so much and the results obtained are far-reaching. They are helping all of us, and while we may not be able to realize this ideal of production directly in our various producing plants, we can carry away many things from Detroit which will be useful to us in our own particular operations. What lesson do we learn from a meeting of this kind? How can we put into practical use the benefits of such a meeting? What are its implications? I think we find first, perhaps, satisfaction to our profession in the tremendous accomplishment that has been made possible by its genius.

Engineers are of two classes; they have dual personalities. There is the creative mind which might be likened to that of the scientist. There is the man who can put into execution the things that are created by his fellow engineer. Then sometimes there are men who combine these two abilities in the proper proportions both to create and weigh their own creations. Those, however, are rare.

But there is another thing that I think we must bear in mind and that is the interdependence of the entire profession. It has been impressed upon the manufacturers of electrical machinery that their business is largely mechanical; also that we depend upon the chemical engineer and the metallurgical engineer. In looking over these plants do you find any element of the profession lacking? Isn't the work of these plants, their construction, their operation, in fact everything about them, the work of all the different classes of engineers so that we cannot divorce ourselves from it? We cannot say that we are mechanical or electrical or civil engineers and accomplish anything without paying tribute to the other classes.

In closing Mr. Herron extended the thanks of the Society to all the participating societies and to members of the local student branches present. He called upon Henry C. Anderson, Henry B. Dirks, and C. J. Freund, honorary chairmen, respectively, of the A.S.M.E. student branches at the University of Michigan, the Michigan State College, and the University of Detroit, who responded briefly to express the appreciation of the student members, and to announce how many students were present. The University of Michigan, with about 140 students, had 80 at the dinner; the Michigan State College, with 62 members, had 40 present; and the University of Detroit was represented by "45 boys and 12 girl friends."

Holley Medal Conferred on Henry Ford

Amid applause, Alex Dow, at the request of President Herron, rose to present Henry Ford for the Holley Medal of The American Society of Mechanical Engineers. The Holley medal was established in memory of Alexander Lyman Holley, chairman of the preliminary meeting at which the organization of the Society was discussed and honorary member in perpetuity.

Mr. Dow explained that the Holley medal was established to be bestowed for some unique and outstanding act of an engineering nature that had accomplished great and timely public benefits. Mr. Ford, a member of the Society since 1915, had been granted this award, he said, by action of the Council on Dec. 1, 1936. Mr. Dow went on to explain that he had been furnished a long account of Mr. Ford's life and successes which he did not propose to read.

"As to why I am chosen to present the award," he continued, "I suppose dates back to the time when Mr. Ford and I were employed by the same employers, with whom we at times agreed, and at other times disagreed handsomely. Technically, Mr. Ford was senior in service and I always respect seniority. Also, of a lot of things he knew much more than I did. One of the things that I find it difficult to teach to engineers was learned by me long before those days: When you have a first-class man who can swing his job, let him alone. I let Mr. Ford very much alone. Nevertheless we discussed many matters. Each of us had some engineering talent of mind. If we observed a happening, a fact, an occurrence, we wanted to know why. Neither of us was particularly anxious to get quantitative values. We found out a great many matters. We found the "why" because we could answer many questions outside of engineering. He and I argued for weeks as to what was the proper pay to secure proper services in our engine room of that day. It was not a large engine room but we looked upon it as a great responsibility. I talked dollars and cents; Henry stuck to one principle, and I commend it to you: The proper pay for a permanent force is the pay that will let a man marry and bring up a family decently. If I were required to put the date on that discussion I would set it as about the year of grace 1897. A lot of water has gone down the Detroit River since then, but the principle has remained. It stays; and I in my small way and Henry Ford in his large way have tried to live up to it with fair success."

Mr. Dow then read the citation: "The Holley medal has been awarded to Henry Ford for revolutionary influence through invention and practice on transportation and on mass-production methods in manufacture."

Upon receiving the medal from Mr. Herron, Mr. Ford responded "Thank you" with characteristic simplicity, and the entire audience rose to greet him with sustained applause.

Honorary Membership Conferred on Mr. Dow

In presenting Mr. Dow to Mr. Herron to receive honorary membership in The American Society of Mechanical Engineers, Harvey N. Davis, who is president of Stevens Institute of Technology, said:

Mr. President, by direction of the Council of The American Society of Mechanical Engineers, I am about to ask you to confer honorary membership upon Alex Dow of Detroit. Conferring an honorary membership is one of the highest honors which it is in the power of this Society to ask you to confer. We like to think that it is conferred only on men of distinguished technical achievement. It is therefore appropriate that I should remind you of a number of the facts that are contained in this document that I hold in my hand. It is full of references to bigger and better boilers, higher steam temperatures, to the courage and wisdom that enables Mr. Dow to undertake and carry out the researches that have led to these developments, to the sagacity that led him to associate with himself some of the finest minds in America in carrying on these researches. On the electrical side it talks about high-voltage cables and even goes back to the time when 60-cycle current was a novelty in this country.

There is, therefore, no question but that Mr. Dow is technically qualified to receive the honor. But some of us feel that there is much more in the greatness of an engineer than mere technical achievement. We read that engineering deals not only with materials but with money and men—particularly men. We believe the man who has attained distinction in the difficult art of management, who has become the head of a great industrial organization, has not left the profession of engineering. He has rather climbed to the top of one of its pinnacles. We honor Mr. Dow, therefore, for the principles which he has just this moment exemplified in his presentation of Mr. Ford to you. He has lived up to those principles through many years of successful management and he has also, during

those years, shown unusual sagacity in financing.

But, sir, an honorary membership has one characteristic that not even a medal has. There is something intimate about conferring honorary membership on a man, something that makes him peculiarly one of us, something that is appropriate, particularly, to a man whose personality has caused us all, both to admire and to love him through the years. It is this quality as honorary member that makes me almost suggest, sir, that it is the very highest honor that we can confer. With confidence that Mr. Dow is superlatively qualified to receive this membership on all these counts, I present him to you, sir, for honorary membership.

Amid applause Mr. Herron handed Mr. Dow the certificate of honorary membership which Mr. Dow received with a brief but characteristically witty response.

Following the reading of a letter from Dean Mortimer E. Cooley, past-president and honorary member of the Society, in which he expressed his regret that his health prevented his attendance at the dinner, Mr. Herron introduced Williard T. Chevalier whose address will be found on pages 503 to 506 of this issue. Dancing followed the delivery of Col. Chevalier's address.

Technical Sessions Cover Many Subjects

As previously reported, the program of the Semi-Annual Meeting was arranged so that technical sessions were held on the afternoons of Tuesday, Wednesday, and Thursday, and on Friday morning. Space does not permit a report of the 32 papers read.

Many of these papers have already appeared in Transactions or MECHANICAL ENGINEERING, and others are scheduled for publication in early issues. The usual difficulty arising from a wealth of material that necessitated several simultaneous sessions was, perhaps, the only unsatisfactory part of the program, and this could not be helped. The sessions were sponsored by Society professional divisions and committees, as follows: Hydraulic, Power, Management, Fuels, Machine-Shop Practice, Process Industries, Railroad, Materials Handling, Petroleum, Iron and Steel, and Oil and Gas Power divisions; and Relations With Colleges, Lubrication, Education and Training, and Research on Cutting of Metals committees.

Presiding officers and official recorders and their assistants, students of the University of Detroit, rendered valued service in the business-like handling of these sessions and the discussions they provoked, and to them those in attendance were heartily grateful.

Many Committees Meet

As usual, the Detroit Semi-Annual Meeting provided an opportunity for meeting of numerous technical and other committees of the Society. Meetings were held of the following Society administrative committees: Education and Training for the Industries, Relations With Colleges, Professional Divisions, and Local Sections.

It is four years since the technical committees of the Society have planned and carried through a series of meetings as long as that included in the program of the Semi-Annual meeting. The research group scheduled six meetings, the standardization group, five, and the power test codes group, one meeting.

In addition to this activity the Special Research Committee on Lubrication, G. B. Karelitz chairman, provided the papers for a technical session and the Special Research Committee on Cutting of Metals, Coleman Sellers, 3rd, chairman, joined with the Machine Shop Practice Division in sponsoring another.

Routine business occupied the greater part of the time of both the research and standardization committees but certain of them recorded significant progress. For instance, the Special Research Committee on Fluid Meters, R. J. S. Pigott chairman, put the finishing touches on the fourth edition of Part 1 of its report and developed plans for the advancement of the research on flow nozzles in progress for three years at the National Bureau of Standards.

Two of the outstanding accomplishments in the standardization field were the complete revision of the present American Standard for Steel Flanges and Flanged Fittings (B16e–1932) and the organization of a new group to develop standards for welding fittings. Owing to the absence of Dr. C. P. Bliss, chairman of Subcommittee No. 3 on Steel Flanges and Flanged Fittings, who is now on a trip to Europe, Alfred Iddles, former chairman of the A.S.M.E. Standardization Committee, presided at the meeting of the subcommittee. A. M. Houser of Chicago, acting as a committee of one, had collected and organized previous to the meeting the desired changes and additions to the present standard so the work of the committee was greatly facilitated. But even with this assistance its session lasted from 2:00 to 7:15 p.m.

All but two of the 13 members of the new subgroup on the standardization of welding fittings were present at its organization meeting. This full attendance on the part of the manufacturers as well as the users was very gratifying, since with the increasing use of welding for piping installations has come a realization of the importance of the standardization of the face-to-face and center-to-end dimensions of this new type of welding fitting. The deliberations at the meeting were marked by complete cordiality and unanimity of purpose and at the close a sub-subgroup of nine was formed to develop a definite proposal for submission to the full committee when it meets again in New York.

A. L. Rice, former vice-president of the A.S.M.E., presided in Dr. Bliss's absence.

Face-to-Face Dimensions of Valves

A standardization project which has extended over a period of years was completed at the meeting of Subcommittee No. 5 on Face-to-Face Dimensions of Ferrous Flanged Valves of Sectional Committee B16. That is to say, the technical part of the standardization process was completed. The approval part is now in progress.

J. R. Tanner, chairman, presided at the meeting and A. D. Sanderson and A. M. Houser, speaking for the American Petroleum Institute and the Manufacturers Standardization Society of the Valve and Fittings Industry, respectively, laid before the committee the conclusions of the past two years' work on this problem. Both of these organizations have only recently crystallized the results of this standardization effort in publications having their own standard form. The first is known as A.P.I. Standard No. 5-G-1 and the second as SP-32-1937.

Sectional Committee B16, organized under the procedure of the American Standards Association, will now take this material and work it into its standard form and arrange for the necessary letter ballots to make this standard in fact an American Standard.

Classification of Surface Qualities

Fifteen attended the open meeting of the Executive Committee of the Sectional Committee on Standardization of Classification and Designation of Surface Qualities (B46). J. R. Weaver of Pittsburgh is chairman of this committee and its other members are E. H. Berges, U. S. Eberhardt, R. F. Gagg, R. E. W. Harrison, S. McMullan, H. J. Wills, and Col. H. K. Rutherford, ex-officio.

This committee has planned a series of quarterly meetings, which began with a meeting in New York, N. Y., in April, 1937, for the purpose of determining the needs of the metal-cutting and forming industries of the country. Obviously,

this meeting in Detroit was scheduled with the aim of ascertaining the views of the automotive industry. The committee was gratified, therefore, to welcome to this meeting representatives of the General Motors, Chrysler, Ford, Chevrolet, and Cadillac corporations.

A new set of test samples of standard surface qualities had been prepared by U. S. Eberhardt, a member of the committee, who was unable to be present at this meeting. These samples and others presented by the guests were inspected by three methods of measurement.

The next meeting of the Executive Committee will be held on July 16 at the National Bureau of Standards.

To Whom Thanks Are Due

No account of a meeting of the Society held outside New York is complete without recognition of the services of the many individuals whose conscientious, thoughtful planning makes for success and the enjoyment of those who attend. In addition to the Society's regular committees and divisions and the many authors of papers, thanks are especially due to the Detroit General Committee which consisted of the following: J. W. Parker, general chairman; L. T. Knocke, chairman, Detroit Section; Dean C. J. Freund, secretary-treasurer, Detroit Section; W. D. Cameron, general treasurer; Sabin Crocker, general secretary; and the officers of other committees.

The other committees were made up as follows: Papers Committee, H. T. Woolson, chairman; Sabin Crocker, secretary; W. A. Carter, Power Division; Julius A. Clauss, Iron and Steel Division; C. L. Eksergian, Subcommittee on Welding; Dean C. J. Freund, Committee on Education and Training for the Industries; A. N. Goddard, Machine-Shop Practice Division; W. W. Nichols, Management Division; and Jervis B. Webb, Materials-Handling Division. Finance Committee, E. W. Nicklin, chairman; W. D. Cameron; Joseph A. Carlin; W. C. DuComb; W. W. Nichols; W. P. Thomas; and W. J. Vogel. Ladies' Committee, Mrs. P. W. Thompson, chairman, F. D. Campbell, secretary; A. M. Selvey, alternate secretary; Mrs. J. W. Armour; Mrs. Sabin Crocker; Mrs. S. M. Dean; Mrs. W. D. Drysdale; Mrs. C. J. Freund; Mrs. A. N. Goddard; Miss Ruth Kluzak; Mrs. L. T. Knocke; Mrs. L. J. Schrenk; Mrs. A. M. Selvey; Miss Hazel Shanks; Mrs. W. J. Vogel; Mrs. J. H. Walker; and Mrs. A. E. White. Hostesses, Mrs. M. W. Benjamin; Mrs. J. F. Jarnagin; Mrs. B. J. Johnson; Miss Ann C. Parker; Mrs. A. W. Thorson; Mrs. H. A. Wagner; and Mrs. S. A. Whitt.

A.S.M.E. Council and Business Meetings at Detroit

PRECEDING the 1937 Semi-Annual Meeting of The American Society of Mechanical Engineers, Hotel Statler, Detroit, Mich., the Executive Committee of the Council met on Sunday, May 16, at 2 p.m. There were present James H. Herron, chairman; Harry R. Westcott, William A. Shoudy, James W. Parker, and Kenneth H. Condit, members of the committee; William T. Conlon (Finance), Crosby Field (Professional Divisions), and W. R. Woolrich (Local Sections), advisory members; and C. E. Davies, secretary.

A report of the secretary's extensive trip to the Pacific Coast on behalf of the Society was presented by Mr. Davies. A résumé of Mr. Davies' report will be found on pages 552 to 553 of this issue. J. N. Landis, D. B. Prentice, H. L. Eggleston, and Ernest Hartford, assistant secretary, were invited to hear the reading of the report.

Educational Conference at Mexico

An invitation from the Comision Organizadora de la III Conferencia Interamericana de Educacion in which the Society was asked to appoint delegates to a conference on education to be held in Mexico City, Mexico, in August, 1937, was reported. The president was authorized to appoint a representative to the conference.

Local Sections Authorized

Upon recommendation of the Committee on Local Sections the combining of the present Meriden and New Britain (Connecticut) sections into one to be known as the New Britain Section was authorized.

It was also voted to authorize the establishment of a local section at Peoria, Ill.

Appointments Reported

The following appointments of members of committees and representatives on special occasions were reported:

Committee on Aims and Objectives: Alfred Iddles, chairman; W. L. Edel, R. G. Macy, G. B. Pegram, E. W. O'Brien, L. E. Jermy, F. E. Cardullo, E. E. Howard, and E. M. Breed. Ex-officio: A. D. Bailey (Standards and Codes), H. R. Westcott (Professional Status), K. W. Jappe (Finance), J. P. Harbeson, Jr. (Speaker, Delegates' Conference, Annual Meeting).

Power Test Code Committee on Stationary Steam-Generating Units, M. W. Benjamin, R. Shallenberger, and R. L. Spencer.

Standardization Sectional Committee on Classification of Coals; E. G. Bailey.

Dues-Exempt Members' Contributions, Harte Cooke; G. W. Farny, F. D. Herbert, S. H. Libby, and W. R. Webster.

Committee on Medals; Harold A. Everett.

Semi-Centennial Celebration, University of Wyoming; June 6–8, 1937, Laramie, Wyo., S. P. Hunt.

Cleveland Engineering Society, Annual Meeting, Cleveland, O.; June 8, 1937; R. J. S. Pigott.

Large Attendance at Council Meeting

The Council meeting, which assembled for its first session in the Hotel Statler at 9:30 a.m. on Monday, May 17, adjourned for an afternoon session at 2 p.m., and for an evening session at 8:30 p.m., all but three members of the Council were present. Letters from these members, John A. Hunter, Ralph E. Flanders, and Conrad N. Lauer, expressed regret at their not being able to attend.

There were present throughout all or part of the three sessions James H. Herron, president; A. A. Potter, Paul Doty, and W. L. Batt, past-presidents; A. D. Bailey, R. L. Sackett, W. A. Shoudy, H. R. Westcott, J. M. Todd, and R. J. S. Pigott, vice-presidents; B. M. Brigman, J. W. Haney, Alfred Iddles, W. Lyle Dudley, W. C. Lindemann, J. W. Parker, E. W. Burbank, K. H. Condit, and S. W. Dudley, managers; and C. E. Davies, secretary, all of the Council. There were also present, W. T. Conlon (Finance), H. N. Davis (Meetings and Program), C. B. Peck (Publications), R. H. McLain (Admissions), Crosby Field (Professional Divisions), W. R. Woolrich, D. B. Prentice, and H. L. Eggleston (Local Sections), H. H. Snelling (Constitution and By-Laws), R. V. Wright, F. V. Larkin, and W. J. Cope (Relations With Colleges), and C. J. Freund (Education and Training for the Industries), chairmen or representatives of standing committees.

Guests present were F. H. Dorner, Walter Rautenstrauch, and E. H. Neff. Ernest Hartford, assistant secretary, and G. A. Stetson, editor, of the staff, also attended.

American Engineering Council

For the information of members of the Council and to provide a basis on which the Society in general might become more fully aware of the purposes and achievements of the American Engineering Council, of which The American Society of Mechanical Engineers has been a member since its organization, Dean A. A. Potter, past-president, A.S.M.E., and president of A.E.C. read a statement he had been asked to prepare for this purpose. Dean Potter's statement will be found on pages 521 to 522 of this issue.

In the discussion which followed there developed the opinion that members of the Society in general were not sufficiently familiar with A.E.C. and its relationship to the profession of engineering and the A.S.M.E., in spite of notes, articles, and reports published from time to time in MECHANICAL ENGINEERING. Hence it was voted to request the Executive Committee to work out means for informing members of the Society on A.E.C. activities. Confidence in the usefulness of the A.E.C. was evident from the attitude of A.S.M.E. Council members.

Calvin W. Rice Memorial

A memorial to Calvin W. Rice, secretary of the A.S.M.E. from 1907 until his sudden death in 1934, has been planned and approved by a committee of the United Engineering Trustees, Inc., of which W. L. Batt is chairman. The memorial will take the form of a tablet to be set in the wall of the main floor lobby of the Engineering Societies Building in New York. Mr. Batt explained that the cost of the memorial would be borne by the four founder societies represented in the U.E.T., and that the trustees had inquired as to what portion of this cost the A.S.M.E. would assume. It was the vote of the Council that the Society should contribute substantially more than its normal one-quarter share toward the cost of the memorial.

Budget for 1937–1938 Adopted

Following full discussion of all items of income and expense listed in a proposed budget for 1937–1938, and a careful review of the policies on which the budget was based, it was voted to adopt the budget recommended by the Finance Committee, the principal items of which appear on this page.

It was also voted to refer to the Finance Committee the policy covering the payment of mileage to members of the Council for traveling expenses incurred in attending Council meetings, with the purpose of working out some means of equalizing the personal contributions to these expenses now borne most heavily by those members who come from long distances.

ESTIMATED INCOME FOR 1937–1938 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, MAY 17, 1937

Income	Actual 1935–1936	Budget 1936–1937	Budget 1937–1938
Initiation and promotion fees (to surplus)	$ 8,961.44	$ 5,000.00	$ 5,000.00
Membership dues	$198,209.83	$198,000.00	$204,000.00
Student dues	11,411.50	12,000.00	13,500.00
Interest and discount	10,451.11	9,100.00	9,100.00
MECHANICAL ENGINEERING, advertising	63,716.04	73,000.00	75,000.00
Mechanical Catalog, advertising	47,547.59	47,000.00	49,000.00
Publications sales	53,980.60	45,000.00	48,000.00
Miscellaneous sales	1,808.00	1,450.00	1,800.00
Contributions, *Journal of Applied Mechanics*	1,490.00	.....	.....
Contributions—unrestricted	373.98	480.00	500.00
Registration fees	245.00	240.00	250.00
Sale of securities	—120.00	A120.00	.....
Sale of equipment	117.00	.....	175.00
Total income	$389,230.65	$386,150.00	$401,325.00
Additions to surplus	20,941.62	15,038.00	19,380.00
	$368,289.03	$371,112.00	$381,945.00

ESTIMATED COST OF ACTIVITIES FOR 1936–1937 ADOPTED BY THE COUNCIL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, MAY 17, 1937

Activity	Expense under committee supervision	Printing and distribution	Direct office expense	Total
Council	$ 5,200.00	.....	.....	$ 5,200.00
Library	8,400.00	.....	.....	8,400.00
A.E.C.	10,000.00	.....	.....	10,000.00
Finance Committee	110.00	.....	.....	110.00
Awards	450.00	.....	.....	450.00
Nominating Committee	500.00	.....	.....	500.00
Local Sections	23,000.00	.....	$ 7,871.67	30,871.67
Meetings and Program	6,500.00	.....	3,459.96	9,959.96
Professional Divisions	2,400.00	.....	3,459.97	5,859.97
Admissions	.....	.....	6,672.61	6,672.61
Employment service	3,000.00	.....	.....	3,000.00
Student Branches	8,900.00	$ 3,680.00	7,476.87	20,056.87
Technical committees	1,000.00	.....	18,704.24	19,704.24
MECHANICAL ENGINEERING, text	.....	27,750.00	13,425.00	41,175.00
Transactions	.....	28,865.00	11,555.00	40,420.00
MECHANICAL ENGINEERING, advertising	.....	16,567.00	20,577.68	37,144.68
Mechanical Catalog	.....	18,800.00	16,157.68	34,957.68
Publications for sale	.....	21,450.00	8,808.00	30,258.00
Retirement fund	4,080.00	.....	.....	4,080.00
Professional services	1,300.00	.....	.....	1,300.00
Secretary's office	.....	.....	16,786.00	16,786.00
Accounting	.....	.....	14,144.00	14,144.00
General service	.....	.....	23,014.32	23,014.32
General office expense	.....	.....	17,880.00	17,880.00
	$74,840.00	$117,112.00	$189,993.00	$381,945.00

Coming Meetings Authorized

Harvey N. Davis announced for the Committee on Meetings and Program that St. Louis had been approved by the Executive Committee of the Council as the meeting place for the 1938 Semi-Annual Meeting, to be held in the week of June 20.

In discussing future plans, Mr. Davis stressed the importance of planning meetings well in advance of their scheduled dates. He pointed out that the budget for his committee provided for four meetings, national in scope and character, to be held in such widely separated cities as to afford every member an opportunity of attending one or more without prohibitive expense in time and money.

Looking ahead to the fall of 1939 when a World's Fair will be in progress in New York City, the Council authorized the adjournment of the 1939 Annual Meeting to a nearby city so that a meeting might be held in New York in September or October of 1939.

Ten Fellows Elected

In 1935 changes in the grades of membership set up a new grade of fellow.

At that time, changes in the Constitution provided that "all properly qualified past or present members of the Council, as of the date this Section is declared in effect, shall become fellows automatically upon application."

On that effective date, there were 99 members to whom this section of the Constitution applied. Of these 84 have been elected to the fellow grade following a scrutiny of their applications, 5 were found to be ineligible, 7 reported that they did not wish to avail themselves of the opportunity of applying for fellowship, and 3 have since died. The names of the elected fellows have been published in other issues of MECHANICAL ENGINEERING with the exception of the ten that follow, whose elections were reported at the meeting in Detroit: Charles H. Benjamin, Frederick N. Bushnell, Edwin S. Carman, William Elmer, William B. Gregory, Horace P. Liversidge, Spencer Miller, Newell Sanders, H. Birchard Taylor, and Arthur West.

In view of the fact that the wishes of all members of the Society eligible for the fellow grade under the section of the Constitution just quoted had been ascertained, the Council voted to eliminate this section, as was provided in the members' vote at the time the section was adopted.

Committee on Local Sections Reports

W. R. Woolrich, chairman of the Committee on Local Sections, submitted a report in which the attention of the Council was called to the variety of problems with which the local sections are often confronted and the necessity for building up confidence in Society operation, particularly through frequent visits of the secretary throughout the country.

Objectives for Education and Training for the Industries

On the recommendation of the Committee on Education and Training for the Industries, four objectives for the guidance of the committee's activities were approved, as follows:

(1) Inform the membership of the Society regarding significant trends and efforts in the nonprofessional training of men for industry.

(2) Aid the members of the Society who are concerned with the stimulation and promotion of the training of men outside the professional level in and for industry.

(3) Determine, or assist in the determination of, principles and procedures for the training of men outside the professional level in and for industry.

(4) Formulate and publish a definition of the technician in industry.

Dues for Students Transferring to Junior Membership

By vote of the Council Article R5, Rule I (Fees and Dues) was amended as follows:

Rule 1 A student member recommended by the honorary chairman of his student branch may be elected by Council to junior membership, the election being subject to his graduation. The payment of dues for one year as junior member at any time prior to September thirtieth following his graduation shall constitute acceptance of election and shall give him all the rights and privileges of the junior-member grade from the date of such payment to October first of the following year.

Rule 2 Such payment may be divided, the student-member paying only the initial quarter's dues ($2.50) at the time of election and the remaining three-quarters of the dues ($7.50) shall be due on September 30.

Membership Development and Interpretation of the Fellow Grade

Administration of the policies affecting election to membership in the recently revised grades has raised questions of interpretation on which the Committee on Admissions has sought guidance. Two special committees, one on Membership Development and the other on Interpretation of the Fellow Grade, were set up by the Council in order to assist the Committee on Admissions. Reports of these committees and comments on them by the Committee on Admissions were read and discussed, and referred to the Committee on Admissions for guidance in its task. Appointment of a special representative committee on the fellow grade was authorized to advise the Committee on Admissions. The Special Committee on Membership Development was asked to proceed with the organization of its activities.

Policies on Member Reinstatement

Considerable discussion of the Society's policies regarding reinstatement of dropped and resigned members and the cancellation of dues resulted in the adoption of principles that were referred to the Board of Review for formulation into a suitable statement of policy.

Recommendations of E.C.P.D.

In the February, 1937, issue of MECHANICAL ENGINEERING, pages 135 to 136, appeared the report of the Committee on Professional Recognition of the Engineer's Council for Professional Development, presented at the annual meeting, Oct. 6, 1936, of the E.C.P.D. This report was considered at the April 23, 1937, meeting of E.C.P.D., and the recommendations of the committee were revised and ordered transmitted to the participating bodies of E.C.P.D. for approval. The A.S.M.E. Council, therefore, voted to refer the recommendation to its Advisory Board on Professional Status. The recommendations in their amended form and the actions on them taken by the E.C.P.D., are as follows:

Revised Recommendation No. 1.—Minimum Definition of an Engineer

E.C.P.D. should urge upon its participating engineering societies the adoption and application of the "Minimum Definition of an Engineer" as a minimum requirement for admission to professional grades of membership. Evidence of professional education (by graduation and/or examinations) should be specifically included in the prescribed membership qualifications.

VOTED: That recommendation as revised, be transmitted to the participating bodies with a recommendation that it be given consideration and put into effect as rapidly as possible.

Recommendation No. 2.—Uniformity in Society Membership Grades

E.C.P.D. should urge and encourage the early adjustment of membership grades in the participating engineering societies to conform to the "Standard Grades of Membership" previously formulated and ratified.

VOTED: That recommendation be transmitted to the participating bodies with a recommendation that it be given consideration and put into effect as rapidly as possible.

Revised Recommendation No. 3.—New State Registration Laws

E.C.P.D. and its participating bodies should render all possible assistance to effect uniformity of registration laws where they now exist or may later be adopted.

VOTED: That recommendation, as revised, be transmitted to the participating bodies with a recommendation that it be given consideration and put into effect as rapidly as possible.

Revised Recommendation No. 4.—Amending Existing Registration Laws

E.C.P.D. and its participating bodies should give assistance and support in amending any state registration law for professional engineers to require evidence of professional education (by graduation and/or examinations) when such is not yet clearly specified as an essential prerequisite for registration.

VOTED: That recommendation, as revised, be transmitted to the participating bodies with a recommendation that it be given consideration and put into effect as rapidly as possible.

Recommendation No. 5.—Registration Prerequisite for Society Membership

E.C.P.D. should recommend to all participating and interested engineering societies that state registration of a candidate be established as a minimum prerequisite for admission to professional grades of membership, with

such provisional exception as present circumstances may justify.

VOTED: That recommendation be referred back to the Committee on Professional Recognition for further study and report at a later date.

Recommendation No. 6 (a)—Engineering Degrees

E.C.P.D. should urge and support the simplification toward greater uniformity, of the wide variation of degrees conferred upon graduation from engineering schools.

VOTED: That recommendation be transmitted to the participating bodies with a recommendation that it be given consideration and put into effect as rapidly as possible.

Recommendation No. 6 (b)—Engineering Degrees

E.C.P.D. should recommend to all engineering schools that the professional degree be eliminated as a degree in course; and that when it is awarded for post-collegiate professional recognition it not be conferred until after the candidate has secured professional registration as a minimum prerequisite.

VOTED: That recommendation be eliminated.

Student Program Successful

Much gratification was expressed with the successful workings of the plan of student-branch operation put into effect some years ago. R. V. Wright, for the Committee on Relations With Colleges, reported that ten highly successful student-branch conferences had been held during the spring of 1937 at which upward of 1500 student members were present. He also reported that several applications for new student branches were pending. The Senior Councilors added their testimony to that by Mr. Wright on the success of the student conferences. It was generally conceded by all who had attended the conferences that the student papers were well-prepared and ably presented.

Adoption of Revised A.S.M.E. Constitution Announced at Business Meeting

The Semi-Annual Business Meeting of The American Society of Mechanical Engineers, required by the Society's Constitution, was called to order at the Hotel Statler, Detroit, at 8 p.m. on Monday, May 17, 1937, by President Herron.

Mr. Davies announced the results of the balloting on the amendments to the Constitution canvassed on April 27, 1937, from the report of the Tellers of Election, which showed that the amended Constitution had been adopted by a majority of the votes cast. In accordance with procedure outlined in the Constitution, President Herron therefore declared the amended Constitution adopted.

An interpretation adopted by the A.S.M.E. Council was then read, as follows:

The Constitution provides that upon the announcement of the result of the ballot upon amendments to the Constitution, the amendments if adopted "shall thereupon take effect." In the By-Laws there is provision that the dues of the Society "are due and payable in advance on the first day of October."

The amendments to the Constitution which have been adopted by vote of the membership provide for changes in the rates of dues for junior members. It is the understanding of the Council that these new rates for junior members go into effect on Oct. 1, 1937, the beginning of the next fiscal year. All other amendments voted by the membership shall take effect immediately.

Members will recall that an explanation of the proposed amendments to the Constitution was prepared by the Committee on Constitution and By-Laws and sent out with the ballot on adoption. The principal points of this document were as follows:

Article C 2, Section 2, Objects. This has been transferred from the Section on Professional Practice and the "emblem" has been added to the name and initials of the Society which are forbidden for use as indicated.

Article C 3, Section 2, Membership. The object of this change is to insure that only a corporate member shall be entitled to receive and exercise a proxy.

Article C 4, Section 8, Admission. Same as former Section 8 (*a*). Former paragraphs (*b*) and (*c*) have been moved to the By-Laws and therefore should be eliminated from the Constitution.

Article C 5, Sections 1 and 2, Fees and Dues. The change in promotion fees and dues for junior members has been made to meet two suggestions. The change in the Constitution put into effect in 1935 set 30 years as the minimum age for the individual to become a member of the Society. The present provision requires that a junior after six years of membership pays full member's dues. This is obviously unfair to the young man who joins immediately after graduation and who at 27 or 28 is compelled to pay member's dues without an opportunity for promotion to that grade. The new provision by which there is no promotion fee from junior to member for the junior who makes application before the age of 33 after five consecutive years, and the provision of intermediate dues of $15, are inserted to encourage junior members to take their promotion in the Society at a minimum of expense.

Articles C 6, C 7, C 8, Officers. The principal reason for the new material in these articles is a rearrangement of old Articles C 6, C 7, and C 8 under more logical headings.

Article C 6. The changes in the various sections of this article merely restate present practice, for example, in section 1, Council action is limited by the results of letter ballots. In section 3, the directors may delegate duties only to corporate members. In section 4, the first meeting of the new Council is definitely specified. In section 5, the change from "or" to "and" (president and treasurer) was made to comply with state law.

Article C 7, Section 4. The change in section 4 requires that the presidential office, in case of vacancy, shall be filled by the vice-president who is senior by length of membership in the Society rather than senior by age.

Article C 8. The important change in this article is the inclusion of the secretary as an officer of the Society. This change has been proposed for many years and is highly advisable as the secretary is an officer of the Society under state law.

Article C 9, Meetings. The changes in this article are primarily in wording with no appreciable change in intent. The several sections were proposed after approval by the other committees interested. The call for a special business meeting at the request of the membership (section 3), is to be made by the secretary rather than by the Council because the Council should not be ordered to take action which is not discretionary. Furthermore, a call for a business meeting by the membership requires prompt action and the secretary should therefore take this action. The change of title to "General Meeting" (section 6), was made to avoid difficulties which arose from the use of other terms.

Article C 11, Section 2, Local Sections. Proposed section 2 is a compromise section approved by the various committees interested. The purpose of adding this section is to give greater importance to the conference of sections delegates and group representatives.

Article C 12, Section 1, Student Branches. This section merely recognizes the organization of Student Branches which have been in existence for some appreciable time.

Article C 16, Section 1, Amendments. This section has been altered in a material point, the proposed section requiring only 20 written endorsements for a proposed change instead of up to ten times that number. It has always been the custom that the vote of only 20 members could order that the proposed amendment be printed and submitted to the membership, hence it is consistent to have the same number propose the change. To balance this reduction, the proposed section requires a favorable vote of two thirds of the votes cast in order to adopt the amendment, instead of the majority heretofore required.

The revised Constitution and the revised By-Laws and Rules necessitated by its adoption and officially approved by the A.S.M.E. Council will be published as part of the "Society Record." They will be distributed to members as a supplement of some early issue of A.S.M.E. Transactions.

Date of 1938 Semi-Annual Meeting Announced

As required by the Society's By-Laws, Mr. Davies announced at the Business Meeting that the 1938 Semi-Annual Meeting of the Society would be held in St. Louis, Mo., during the week of June 20, 1938.

Secretary Davies Reports His First Extensive Trip for the A.S.M.E.

A TRIP of 13,000 miles, starting March 28 and ending at Detroit on May 17, gave the Secretary of The American Society of Mechanical Engineers, opportunity to become acquainted with many members and students in Louisiana, Texas, Colorado, Wyoming, the Pacific States, Nevada, Montana, the Dakotas, Minnesota, and Wisconsin. This trip, the first the Secretary has made to this area since he assumed his office and long-delayed because of Society business near headquarters, was most fruitful in increasing mutual understanding of Society problems and in laying a better groundwork of acquaintanceship on which to approach future tasks. Everywhere members extended a hearty welcome and gave generously of their time so that the Secretary might make the most of his visits.

While most of the results of the trip will be helpful primarily in Society administration, some general observations may be of broader interest for the membership at large.

Student Branches Doing Well

The student-branch work is being carried on everywhere with enthusiasm and success. The student plan, initiated in 1931 and extended in 1934 to cover the entire country, provided for bringing qualified students into the Society as student members, gave an opportunity for automatic promotion to the junior-member grade without initiation fee, and established ten regional conferences where the representatives of 115 student branches might meet and compete for prizes awarded for the best presentations of papers on technical subjects. The Secretary attended one of these conferences at Stillwater, Okla., which was a huge success. His visits to the 26 branches occurred just before or just after the conferences and everywhere keen interest was reported. The remarkable enthusiasm of the students is best shown by the fact that many groups traveled one thousand miles or more to attend and return, and from one branch six boys traveled 1700 miles. The caliber of papers and the way they were presented hold great promise for the future of A.S.M.E. meetings, when these students take their places on the senior programs.

One suggestion, prompted by observation and inquiry at the various schools, is the desirability of encouraging among the students the discussion of the traditions, achievements, ideals, duties, and social functions of the engineering profession. Older engineers in meeting with students will do well to stimulate discussion of such topics so that the young graduate may be equipped not only with adequate scholastic training but with professional ideals and social concepts that will increase his satisfaction in his professional life.

Many of the schools visited were located in places where little industry is to be found. Despite this and other handicaps, the faculties of these schools have been carrying on their work with real courage and devotion to the fine groups

PROF. C. W. CRAWFORD OF TEXAS A. & M. AND PROF. H. E. DEGLER OF TEXAS UNIVERSITY AT TAYLOR, TEXAS (NEUTRAL GROUND)

DEAN W. R. WOOLRICH AND PROF. P. E. SHORT OF TEXAS UNIVERSITY ABSORBING ORIENTAL ATMOSPHERE IN SAN ANTONIO

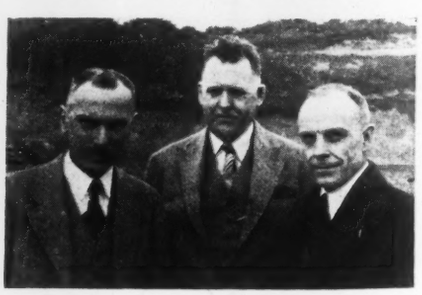
OFFICIALS AT STILLWATER STUDENT BRANCH CONFERENCE. BACK ROW, LEFT TO RIGHT: HOLLIS P. PORTER, J. H. ENGELBRECHT, ROSCOE AYERS, CHAIRMAN, MID-CONTINENT SECTION; FRONT ROW, LEFT TO RIGHT: E. W. BURBANK (COUNCIL MEMBER), BETTY SLOCOMBE, H. L. STINSON, A. J. KERR, W. H. STUEVE

STUDENTS AT COLORADO SCHOOL OF MINES

C. E. NEWCOMB AND S. D. OCCHIPINTI, STUDENTS AT UNIVERSITY OF WYOMING, LARAMIE, WYO.

BETTY SLOCOMBE "ENGINEERING QUEEN" FOR STUDENT BRANCH CONFERENCE AT OKLAHOMA A. & M. COLLEGE, STILLWATER, OKLA.

STUDENTS AT STANFORD UNIVERSITY



GUIDES FOR A DAY'S TRIP ALONG THE NORTHWEST COAST. LEFT TO RIGHT: PROF. S. H. GRAF, W. H. MARTIN, J. C. OTHUS, ALL OF OREGON STATE COLLEGE, CORVALLIS, ORE.

of young men who come to them for instruction. This trip revealed possibilities of increased aid to these schools by (1) encouraging visits by qualified speakers, (2) placing graduates, and (3) searching out research problems that may be taken up by qualified men in the various schools.

Major Problems Discussed With Members

Three major problems were discussed with the members of the Society.

Knowing that a proposal to hold four Society meetings each year was to be discussed at the Detroit meeting of the Council, the Secretary took every opportunity to sound out member opinion. The new plan provides for one meeting each year in the Pacific Coast area, one in the great middle-west industrial area, and one in or near New York, while in alternate years the fourth meeting will be held in New England or the South. The plan further proposes that these meetings shall be national in character and participation.

For several years the Committee on Meetings and Program has been endeavoring to relieve the pressure of eighty or more papers at the Annual Meeting in New York by providing as many as seven simultaneous sessions. The holding of four meetings at places that permit the attendance of members without too great sacrifice in time and expense is the first step. To be fully successful, the cooperation of authors and local groups is needed. Discussion of this plan with the section officers consulted on the trip resulted in enthusiastic support of the idea and pledges of cooperation in carrying it out.

The second subject discussed by the Secretary and those whom he met was the policy of intensifying the procedure for scrutinizing the attainments of candidates for admission and promotion in the Society. This policy also met with general approval.

The third subject concerned the junior-group movement. The student-branch plan already mentioned has brought a large number of junior members into the Society. During the period of adjustment to professional work, these junior members have sought an outlet for their activity in the Society with the result that junior groups have been formed in thirty-two sections. Particularly enthusiastic groups were encountered by the Secretary at Houston, Portland, Milwaukee, and Chicago. A group has been in existence in Los Angeles for some time and is carrying on with gratifying results. The junior-group activity is of great importance to the future of the profession, and its encouragement is commended to all section officers for consideration.

Publications were also discussed with members and section officers, and enthusiastic comments on MECHANICAL ENGINEERING were heard.

The Secretary extends his deep appreciation to the scores of members and students who greeted and aided him. A few are shown in the accompanying illustrations. Lack of uniformity in the Secretary's photographic technique and space limitations make it impossible to show all of the photographs, which is deeply regretted.—C. E. DAVIES.

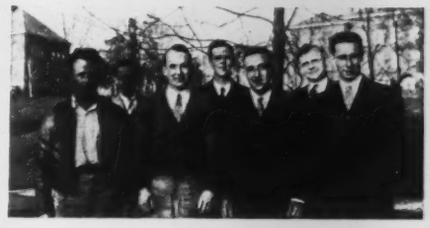
A GROUP AT THE UNIVERSITY OF CALIFORNIA WITH PROF. H. B. LANGILLE

BOB FOSTER, CHAIRMAN OF UNIVERSITY OF WASHINGTON STUDENT BRANCH, WITH W. LYLE DUDLEY OF SEATTLE (MEMBER OF THE COUNCIL)

AT BONNEVILLE—TOM BERRY, PAUL HESLOP (CHAIRMAN), AND F. L. DAVIS OF PORTLAND, ORE.

GUIDES IN THE INLAND EMPIRE, DAVID GRAY AND CHARLES CARPENTER OF SPOKANE

GROUP AT MOSCOW, IDAHO



SOME MEMBERS OF STUDENT BRANCH WITH SECRETARY DAVIES, STATE COLLEGE OF WASHINGTON, PULLMAN, APRIL 30, 1937. (PHOTO BY H. H. LANGDON)

DEAN R. M. DOLVE OF NORTH DAKOTA AGRICULTURAL COLLEGE AND ORVIE HIGHUM OF GRAND FORKS, N. D.

A. E. LYNGSTAD, STUDENT CHAIRMAN, AND PROF. I. T. STRATE AT SOUTH DAKOTA STATE COLLEGE, BROOKINGS, S. D.

A. B. NEWTON, MINNEAPOLIS, MINN.

A.S.M.E. Meeting at Erie, Pa., Oct. 4–6

The First of Series of Four Annual National Meetings Being Planned

PLANS for the 1937 Fall Meeting of the A.S.M.E. to be held at Erie, Pa., October 4–6, are beginning to crystallize and to give promise of an attractive program.

Papers on Power, Railroads, Fuels, and Petroleum

While the following outline is still subject to revision or expansion there are scheduled two sessions on power, with papers on such topics as new superheater metal, the high-pressure unit in the power plant at Rochester, steam flow in nozzles, and operation of centrifugal pumps in parallel. The Railroad Division will be represented with papers on locomotive stokers and flexible mounting of Diesel motors. One session will be sponsored by the Fuels Division with papers on gas producers and molal combustion calculation of stack losses when burning petroleum fuels.

The Petroleum Division is planning two sessions, one devoted to the flow of fluids other than water and metering of gases and the other on the manufacture of petroleum apparatus as carried on at Oil City, Pa. A visit is also being planned to plants manufacturing petroleum apparatus.

Training of apprentices and engineering graduates will be discussed and an opportunity provided not only to visit the large mill of the Hammermill Paper Co., but also to hear a paper describing the processes used.

Do You Plan to Attend?

The Erie Committee as well as the committees of the Professional Divisions are engaged in perfecting the program and developing additional papers of interest. While a special circular will be distributed prior to the meeting, the local committee would like to hear from those members who expect to attend. The chairman is B. S. Cain, General Electric Co., Erie, Pa. The Lawrence Hotel will be the headquarters for the meeting, offering excellent facilities.

Inspection Trips

Erie is an industrial city of considerable importance with a diversification of products manufactured by many interesting processes within the field of mechanical engineering. Some of the plants which have already consented to open their doors include the General Electric Company, where most of the apparatus manufactured by that company for railroad use is made, and also where all of the refrigerator bodies are manufactured and their assembly with the refrigerating units completed. This work has been developed on a production basis with the assembly similar to that used in automobile manufacture. This particular visit will be of interest to women attending the meeting, as will also the plant of the American Sterilizer Company, whose products include the highly specialized instruments and apparatus used by the medical profession.

The Erie Forge and Steel Company, the Oil Well Supply Company, and the National Transit Pump and Machine Company plants are among several others that will be available for inspection trips.

Erie Also a Good Play Spot

Erie is particularly fortunate in being situated at a point on Lake Erie where a peninsula stretches out into the lake for several miles, thereby affording an excellent playground for its residents. Several excellent golf courses are available and special entertainment is being arranged for visiting ladies so that the general program should prove attractive and warrant the expectation of a large attendance.

Further details regarding the products of the plants to be visited and the titles of papers and authors will be announced in the August and September issues of MECHANICAL ENGINEERING.

Knoxville A.S.M.E. Section Elects Officers

AT A MEETING of the Knoxville Section of The American Society of Mechanical Engineers, held at Kingsport, Tenn., May 24, 1937, Ford L. Wilkinson was elected president of the section. Other officers elected were James Ellis, vice-president, C. G. Worthington secretary-treasurer; and D. W. Benscoter, William F. Searle, Jr., and D. R. Shearer, members of the executive committee.

A paper by James Ellis on "The Mechanical Engineers' Work in a Chemical Plant," was received with enthusiasm at the afternoon session; and in the evening J. C. Hodge, of the Babcock and Wilcox Company, spoke on "Fundamentals of Modern Welding." Eugene W. O'Brien, former member of the A.S.M.E. Council, spoke briefly at the conclusion of the meeting.

How to Become an A.S.M.E. Life Member

PROVISIONS are made in the By-Laws of The American Society of Mechanical Engineers by which a Fellow, Member, or Associate may become a Life Fellow, Life Member, or Life Associate by paying the Society at one time the present worth of an annuity equal to that member's dues for the period for which he is required to pay dues.

The By-Laws also contain the provision that members who have paid dues for 35 years, who shall have reached the age of 70 years, after having paid dues for 30 years, are not required to pay further dues.

At the present time 67 are life members. The schedule of rates for life membership has been prepared by the Finance Committee of the Society and is available to the member who wishes to avail himself of this opportunity.

Program of A.S.M.E. Oil and Gas Power Division for Penn State Conference

Papers Give Promise of Active Technical Sessions

THE Program Committee of the A.S.M.E. Oil and Gas Power Division announces that the technical program scheduled for the Conference at Penn State College, August 18 to 21, is determined, with the exception of several possible last-minute additions. Papers which have already been definitely scheduled are as follows:

Progress Reports, by Diesel-engine manufacturers and locomotive builders including statements by American Locomotive Company, Caterpillar Tractor Company, Davenport Besler Corporation, De LaVergne Engine Company, Hercules Motors Corporation, Ingersoll-Rand Company, Nordberg Manufacturing Company, and others to be announced later.

The U. S. Navy Contribution to Diesel Engine Development, by E. C. Magdeburger, Bureau of Engineering, U. S. Navy Department

Convertible Gas-Oil Engines (author to be announced)

Sewerage Gas Engines, by W. B. Walraven, Springfield, Ill., Sanitary District

Oil Flow Through Fuel Nozzles, by K. J. DeJuhasz, Penn State College

Polymerization of Fuel Oils, by Gustav Egloff, Universal Oil Products Company

Oil-Engine Power Cost Report for 1936, by H. C. Major, Chairman of the Oil Engine Power Cost Subcommittee

Waste-Heat Recovery From Diesel Engines, by Glenn C. Boyer, Burns & McDonnell Engineering Company

Symposium on Operating Problems with prepared statements by leading operators

Correlation of Laboratory Tests on Fuel Oils With Field Operation, by W. F. Joachim, U. S. Naval Experiment Station, Annapolis, Md.

Recent Developments in Automotive-Type Diesel Engines, by O. D. Treiber, Hercules Motors Corporation

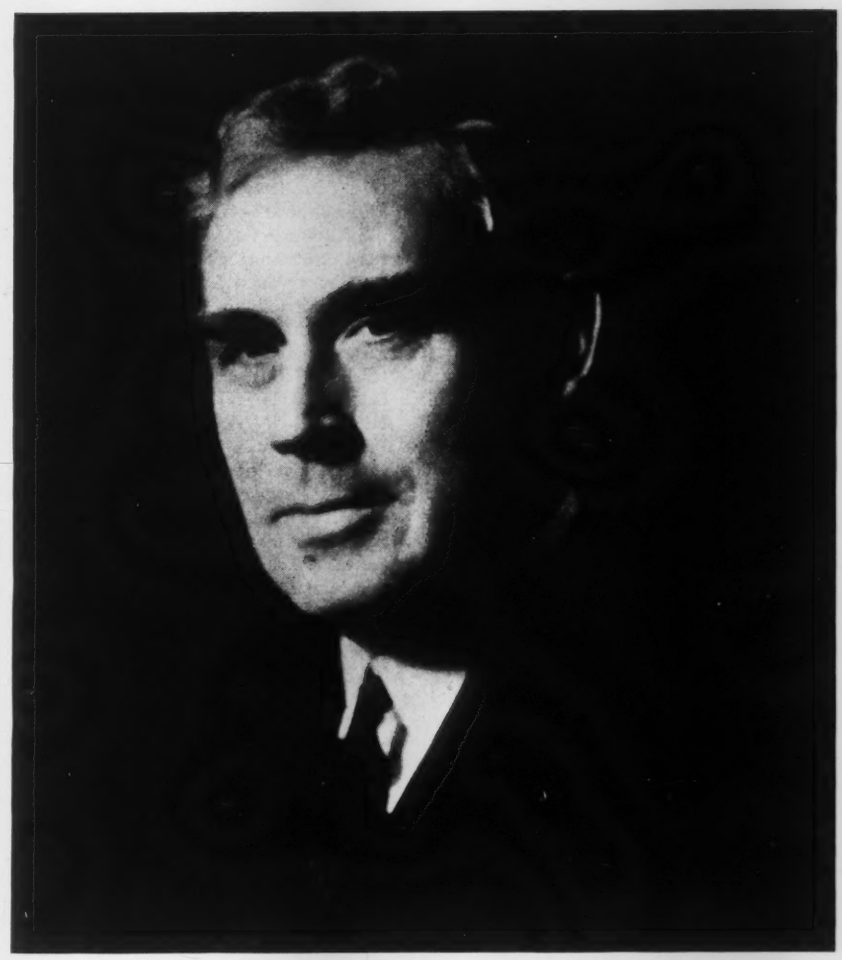
Some Operating and Upkeep Costs for Diesel Locomotives, by J. W. Anderson, Consulting Engineer.

The program shows evidence of careful planning on the part of the Papers Committee and will appeal to Diesel engineers as promising an active technical session.

Oil-Engine Power Cost Report for 1935

A FEW copies of the 1935 Report on Oil-Engine Power Cost are still available for sale.

Those wishing to have a complete file of cost reports but who have not as yet secured their 1935 copy are urged to send their orders in as soon as possible. The price is $1.



HARVEY N. DAVIS
Nominated for President

Nominated for
A.S.M.E. OFFICERS IN 1937-1938

AT THE Semi-Annual Meeting of The American Society of Mechanical Engineers, Detroit, Mich., May 17–21, Harvey N. Davis, president of Stevens Institute of Technology, Hoboken, N. J., was nominated by the Nominating Committee for the office of President of the Society.

Vice-presidents nominated to serve on the Council of the Society were F. O. Hoagland, Hartford, Conn., B. M. Brigman, Louisville, Ky., Harte Cooke, Auburn, N. Y., W. H. McBryde, San Francisco, Calif., and L. W. Wallace, Chicago, Ill.

Nominations for members of the Council to serve as managers were: Carl Bausch, Rochester, N. Y., S. B. Earle, Clemson College, S. C., F. H. Prouty, Denver, Col.

The National Nominating Committee for 1937 which reported the nominations consists of Charles M. Allen, Worcester, Mass., chairman, with T. H. Beard, Bridgeport, Conn., alternate; F. M. Gibson, Brooklyn, N. Y., secretary, with E. G. Bailey, New York, N. Y., and W. E. Caldwell, New York, N. Y., alternates; A. L. DeLeeuw, Plainfield, N. J., with V. M. Palmer, Rochester, N. Y., alternate; B. E. Short, Austin, Tex., with J. W. Eshelman, Birmingham, Ala., alternate; L. E. Jermy, Cleveland, Ohio, with C. A. Young, Lafayette, Ind., and K. F. Treschow, Pittsburgh, Pa., alternates; A. A. Luebs, Lincoln, Neb., with C. F. Moulton, Omaha, Neb., and W. L. DeBaufre, Lincoln, Neb., alternates; J. C. Othus, Corvallis, Ore., with P. L. Heslop, Portland, Ore., and F. L. Davis, Portland, Ore., alternates.

Harvey N. Davis

HARVEY NATHANIEL DAVIS, third president of Stevens Institute of Technology, engineer, and scientist, who has been nominated for the office of president of The American Society of Mechanical Engineers, was born at Providence, R. I., in 1881. He was graduated from Brown University with an A.B. degree in 1901 and, through postgraduate work, received his A.M. degree from Brown in 1902 and A.M. and Ph.D. degrees from Harvard University in 1903 and 1906, respectively.

After spending the year 1901–1902 as instructor in mathematics at Brown, Doctor Davis enrolled at Harvard as a student and later was made instructor in physics. He was appointed assistant professor of physics at the latter institution in 1910 and, nine years later, was made professor of mechanical engineering. He held this chair until 1928, when he was elected president of Stevens Institute of Technology, Hoboken, N. J.

In 1920, he was elected a member of the Society, and a Fellow in 1936. He was appointed a manager in 1929 to fill the unexpired term of L. B. McMillan, who was fatally injured in an airplane accident, and was elected vice-president the following year. At present, Doctor Davis is chairman of the Meetings and Program Committee and its representative on the Council, and a member of the Advisory Board on Technology and the U. S. National Commit-

tee of the International Electrotechnical Commission.

Doctor Davis has served as consulting engineer for the Franklin Railway Supply and Air Reduction companies. In 1917–1918, he was in charge of the computation room at the Lynn, Mass., turbine plant of the General Electric Company.

During the World War, Doctor Davis was active in the helium investigations that were conducted by the Army, the Navy, and the U. S. Bureau of Mines, first as a member of a committee of scientists appointed to study and report on a new method of obtaining helium from natural gas and, later, as aeronautical engineer in the division of science and research in the U. S. Air Service. His research work has been chiefly in thermodynamics, with particular reference to steam tables. He has a number of inventions to his credit, including an improvement in steam turbines and five processes, with apparatus, for liquefaction and rectification of air. In the steam field, he was one of the group that organized the first conference at Cambridge, out of which the present A.S.M.E. steam research program has grown.

He is a member of Sigma Chi, Phi Beta Kappa, and Tau Beta Pi; a fellow of the American Association for the Advancement of Science, American Physical Society, and American Academy of Arts and Sciences; a life member of the American Mathematical Society; and a member of the Washington, D. C., Academy of Sciences and the American Philosophical Society. He is also chairman of the Advisory Board on Smoke Abatement of the Department of Smoke Regulation of Hudson County, New Jersey.

In addition to the well-known "Tables and Diagrams of the Thermal Properties of Saturated and Superheated Steam," which he wrote in collaboration with L. S. Marks, Doctor Davis is the joint author, with H. N. Black, of "Practical Physics" and "New Practical Physics." He has also written several technical papers.

In 1928, Doctor Davis received the honorary degrees of LL.D. from Rutgers University and Sc.D. from his alma mater, Brown University. New York University conferred the honorary degree of Doctor of Engineering upon him in 1906.

For Vice-Presidents

B. M. Brigman

B. M. BRIGMAN, who has been nominated for the office of Vice-President of The American Society of Mechanical Engineers, is dean of the Speed Scientific School, University of Louisville. He was born at Louisville, Ky., on Feb. 25, 1881. From 1901 to 1903, he was a student at the University of Kentucky. He received the degree of B.S. in 1908 and that of M.Sc. in 1912 from the University of Louisville, and did postgraduate work at the University of Wisconsin in the summer of 1915.

From 1904 to 1907, he was an instructor in manual arts at the University School and, for

B. M. BRIGMAN

the next nine years, held a similar position at the Du Pont Manual Training High School, both of Louisville. He was appointed assistant professor of physics at the University of Louisville in 1916, was promoted to the professorship of engineering and drawing in 1919, organized the school of engineering between 1923 and 1925, and was appointed dean of the Speed Scientific School in 1924.

Dean Brigman was elected to membership in The American Society of Mechanical Engineers in 1923 and a Fellow in 1936, and served as a Manager from 1934 to 1937. He is also a member of the Society for the Promotion of Engineering Education, American Association for the Advancement of Science, American Society for Testing Materials, and American Institute of Electrical Engineers. In 1933 and 1934, he was vice-president of the Society for the Promotion of Engineering Education and, at present, represents that body and The American Society of Mechanical Engineers on the Engineers' Council for Professional Development Delegatory Committee of Group IV. He was a member of American Institute of Electrical Engineers Committee on the Engineering Profession in 1930 and 1931 and has been a member of its Committee on Legislation Affecting the Engineering Profession since 1931. During the World War, he was in charge of the speakers' bureau, Council of National Defense, and the Bureau of War Savings Stamps for Kentucky. Other civic activities include membership on the Planning and Zoning Commission of the City of Louisville and chairman of the Smoke Abatement League of Louisville.

Frank O. Hoagland

FRANK O. HOAGLAND, one of the nominees for the office of Vice-President of The American Society of Mechanical Engineers, is master mechanic of the Pratt & Whitney division, Niles-Bement-Pond Company, Hartford, Conn. He was educated in Sweden, his native land.

His early machine-shop experience was obtained with John Stark, a manufacturer of watchmakers' and machinists' tools and instruments at Waltham, Mass. For some years prior to, and during, the World War, Mr. Hoagland was chief engineer of the Ilion, N. Y., and Bridgeport, Conn., plants of the Remington Arms Company. He has been identified with the machine-tool industry for several years and is now with the Pratt & Whitney division of the Niles-Bement-Pond Company, where he is master mechanic.

Mr. Hoagland was elected a member of the Society in 1912. At present, he is a member of the executive committee of the Hartford Section and is active in standardization work, being a member of the A.S.A. Sectional Committees on Allowances and Tolerances for Cylindrical Parts and Limit Gages, Classification and Designation of Surface Qualities, and

F. O. HOAGLAND

two technical committees of the Sectional Committee on Small Tools and Machine-Tool Elements, as well as A.S.M.E. representative on two other technical committees. He is a member of the American Society of Swedish Engineers and the National Machine Tool Builders Association and represents the latter organization on the A.S.A. Council.

Harte Cooke

HARTE COOKE, one of the nominees for the office of Vice-President of The American Society of Mechanical Engineers, is mechanical engineer, Diesel-engine division, American Locomotive Company, Auburn, N. Y. He was born at Whitehall, N. Y., in 1871, and attended Rensselaer Polytechnic Institute, Troy, N. Y., but left before graduating to accept a position in his home town.

In 1892, he went to Auburn to work as a draftsman for the McIntosh & Seymour Corporation, builder of steam engines, and has been associated with that organization ever since. In 1900, he was admitted into partnership in the firm and, at various times, performed all the duties associated with a business of that character. Building of Diesel engines was started by the company in 1913, and in 1929 the business was taken over by the American Locomotive Company and became the Diesel-engine division of that organization.

Mr. Cooke was elected an associate member of the Society in 1897 and was transferred to full membership four years later. He has been very active in the affairs of the Society, particularly in connection with the Power Test Codes Committee and its technical committees, having been a member of the main committee for approximately 20 years. In addition, he

has been a member since 1914 of the Reciprocating Steam Engines and Internal-Combustion Engines Technical Committees and of the Speed-Responsive Governors Technical Committee for the last 15 years. Other committee activities include two terms on the Nominating Committee and membership on the Board of Honors and Awards and its Special Committee on Medals since 1934, the executive committee of the Oil and Gas Power Division since its formation in 1921, and the A.S.A. Sectional Committee on Specifications for Fuel Oils for many years.

Membership in other engineering societies

HARTE COOKE

includes the Society of Naval Architects and Marine Engineers and the Society of Automotive Engineers. He was vice-president representing the Diesel-engine engineering activity of the latter in 1933. For many years, Mr. Cooke has been a member of the American Association for the Advancement of Science.

W. H. McBryde

WARREN HORTON McBRYDE, who has been nominated for the office of Vice-President of The American Society of Mechanical Engineers, is a consulting engineer of San Francisco, Calif. He was born at Mobile, Ala., in 1876. At the age of 17, he entered the Alabama Polytechnic Institute, Auburn, where he specialized in electrical and mechanical engineering, and was graduated in 1897 with a B.S. degree.

For the first year after graduation, he was employed by the Mobile Light & Railroad Co. and did architectural designing and drafting for George F. Barber & Co., Knoxville, Tenn. During the Spanish-American War, he served for a few months in the U. S. Light House Department and had charge of the submarine mines, search lights, and electrical equipment guarding the entrance to Mobile Bay and then was made chief electrician on the U. S. Army Transport *Sheridan*, made a voyage from New York, N. Y., via the Suez Canal, the Philippines, and Nagasaki, Japan, to San Francisco, where he was honorably discharged. From 1899 to 1903, Mr. McBryde was employed by the Yuba Electric Power Company as assistant resident engineer in charge of construction on the Colgate hydroelectric powerhouse, Peyton Chemical Company, San Francisco, and Bay Counties Power Company, also of San Francisco, as chief draftsman and assistant to the chief electrical and mechanical engineer. He was resident engineer in charge of construction at Gibbstown, N. J., for the E. I. du Pont de Nemours Powder Company from 1903 to 1905 and was then transferred to Hercules, Calif. In 1906, he was appointed chief of the West Coast engineering and construction department of the du Pont organization and, subsequently, became assistant superintendent of its Hercules plant. When, in 1912, as a result of the suit by the government against E. I. du Pont de Nemours Powder Company, the Hercules Powder Company was formed to take over this and a number of other plants and portion of the business of the du Pont Company, he retained this position and remained with the new company until 1919. In this period, Mr. McBryde was in charge of all maintenance and repairs and handled many important engineering problems in connection with the hurried construction of 12 large TNT plants, the necessary nitric and sulphuric-acid plants, and many other buildings during the World War. He was also in charge of the labor and industrial-relations department of the company and, with the help of its employment manager, secured positions for three quarters of the four thousand men under his supervision when demobilization came. In 1919, he became secretary and assistant to the general manager, California & Hawaiian Sugar Refining Co., San Francisco, and handled various engineering problems until 1927, when he engaged in business on his own account as a consulting engineer.

Mr. McBryde was elected a member of the Society in 1921. He was chairman of the San Francisco Section in 1925 and 1926, when the Spring Meeting was held at San Francisco in the latter year. As a delegate from the Section, he attended the 1926 Annual Meeting of the Society in New York, N. Y., and the celebration at Washington, D. C., in 1931, of the 50th anniversary of the formation of the Society. In company with Secretary Rice, Mr. McBryde represented the Society at the 75th anniversary of the Verein deutscher Ingenieure at Cologne in June, 1931; he also attended the 1931 and 1935 spring meetings of the Institution of Mechanical Engineers at Cambridge and Bath, respectively. Mr. McBryde was one of the founders of the Engineering Societies Employment Service in San Francisco.

Other activities include election as mayor of Hercules, Calif., and supervisor of Contra Costa County, while a resident of that city; San Francisco Engineers' Club; San Francisco Electrical Development League; and the presidency of the Industrial Association of San Francisco in 1921, the last being in recognition of his experience as an employer and his interest in workingmen.

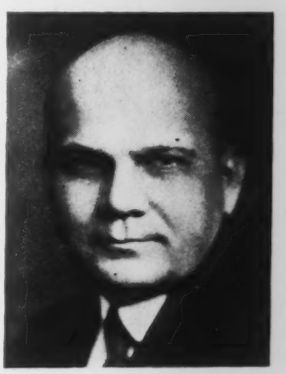
L. W. Wallace

L. W. WALLACE, nominee for the office of Vice-President of The American Society of Mechanical Engineers, is director of equipment research, Association of American Railroads, Chicago, Ill. He was born at Webberville, Tex., in 1881. From 1900 to 1903, he studied mechanical engineering at the Agricultural and Mechanical College of Texas, which granted him a B.S. in mechanical engineering.

For three years after graduation, he was a special apprentice in the Cleburne, Tex., shops of the Gulf, Colorado & Santa Fe Railway Co. In September, 1906, Mr. Wallace became a member of the faculty of the mechanical-engineering department at Purdue University as an assistant in railway mechanical engineering. He was appointed professor of railway and industrial management at Purdue in 1914 and had charge of all railway mechanical work until 1917, when he resigned. In his 11 years at Purdue, Mr. Wallace was in intimate contact with the research work conducted there on the mechanical equipment of railroads and had direct charge of the courses in car and locomotive design. All of his summer vacations, except two, were spent in railroad work, such as car and locomotive design, standing and road tests of locomotives, preparation of instruction booklets on many phases of car and locomotive construction and operation, tests of frictional resistance due to sharp wheel flanges, comparative tests of rigid and flexible freight-car trucks, refrigerator-car tests, and road and laboratory tests on the behavior of locomotive cinders.

From June, 1917, to March, 1919, Mr. Wallace was assistant general manager of the Diamond Chain & Mfg. Co., Indianapolis, Ind., and had direct charge of all production. He left that company to become director of the Red Cross Institute for the Blind at Baltimore, Md., which was founded by the American Red Cross to train those blinded during military service in the World War. Mr. Wallace organized the institution and mobilized a staff to teach handicrafts and conduct vocational and professional courses.

In January, 1921, he became secretary of the Federated American Engineering Societies, predecessor of the American Engineering Council. In that capacity, Mr. Wallace organized and directed a number of technical studies,



L. W. WALLACE

some of which exerted a profound effect upon American industry. Among these were Waste in Industry; Civil Aviation; Safety and Production; Industrial Coal—Purchase, Delivery, and Storage; Street-Traffic Signs, Signals, and Markings; and Twelve-Hour Shift in American Industry. Numerous briefs and bills were prepared by him for consideration by important Government officials and members of

Congress, and he served on many governmental, industrial, and professional committees and boards, including confidential advisory groups relating to the functions, organization, and activities of the Federal Government.

Mr. Wallace resigned, in January, 1934, to become vice-president of the W. S. Lee Engineering Corporation in charge of its Washington, D. C., office. On Feb. 1, 1935, he became director of equipment research for the Association of American Railroads, where he is in charge of all research work relating to motive power and car equipment, both freight and passenger.

While at Purdue, he began an investigation of the behavior of locomotive cinders, which has been continued intermittently until now. He has appeared as an expert witness in nearly 50 fire cases for railroads in the last 20 years, and, in all of these, verdicts that were favorable to the railroad companies have been returned. "Fire Losses—Locomotive Sparks," a book that he wrote in 1921, has been used as an authoritative reference in many lawsuits. In addition, Mr. Wallace is the author of "Steel Freight-Car Design," contributed the chapter on Management and Government in "Toward Civilization," by Charles A. Beard, and has written many articles, papers, and addresses on railway, industrial, public-affairs, and economic topics.

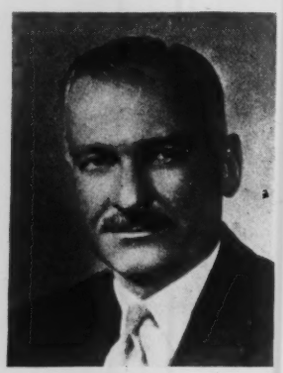
Purdue conferred an M.E. upon him in 1912 and followed this with an honorary degree of Doctor of Engineering in 1932. He is an honorary member of the Masaryk Academy of Work in Czechoslovakia, and, in 1924, that government conferred upon him the Order of the White Lion. Mr. Wallace was elected a member of The American Society of Mechanical Engineers in 1912. He was a charter member of the Society of Industrial Engineers and served four consecutive terms as president. In addition, he is a member of the Academy of Science, American Academy of Political and Social Science, and Washington Society of Engineers, and organized the Eyesight Conservation Council of America and served for 12 years as chairman of its board of directors.

For Managers

Carl L. Bausch

CARL L. BAUSCH, nominated for the office of Manager of The American Society of Mechanical Engineers, is vice-president in charge of research and engineering of the Bausch & Lomb Optical Co., Rochester, N. Y. He was born at Syracuse, N. Y., in 1887, and was graduated from Syracuse University in 1909 with the degree of M.E.

Although he specialized in power engineering while at college, he accepted a position with Bausch & Lomb after graduation and worked there as a machinist and toolmaker until 1912, when Henry L. Gantt, who had been engaged to install his production-control system, selected Mr. Bausch to handle the work in the machine and tool department.



CARL L. BAUSCH

He was made assistant foreman of the department and, later, promoted to foreman. During the World War, Mr. Bausch, as superintendent of the mechanical division, was responsible both for selecting and for maintaining the mechanical equipment of the entire plant.

The duties of superintendent of the spectacle-frame division were added shortly after, and, in 1921, he was made chief engineer. Five years later, Mr. Bausch was appointed manager of research and engineering. In 1931, he was elected to the board of directors, and, in 1935, vice-president in charge of research and engineering, his present position.

Mr. Bausch was elected a junior member of the Society in 1911, became an associate in 1913, and was transferred to member grade in 1921. He was chairman of the Rochester Section for several years and has been a member of the Board of Honors and Awards Special Committee on Medals since 1934.

Numerous patents on optical machinery and instruments have been granted to Mr. Bausch, who is also the author of several articles on engineering subjects, most of them pertaining to the optical industry. He is a life member of both the Optical Society of America and the American Association for the Advancement of Science; a member of the Rochester Engineering Society, American Military Engineers, and the Advisory Committee on Aerial Mapping of Syracuse University. Mr. Bausch is assistant chief of the Rochester Ordnance District and a member of the honorary engineering fraternity of Tau Beta Pi.

Samuel B. Earle

SAMUEL BROADUS EARLE, who has been nominated for the office of Manager of The American Society of Mechanical Engineers, is dean of the School of Engineering, professor of mechanical engineering, and director of the engineering experiment station, Clemson Agricultural and Mechanical College, Clemson, S. C. He was born at Gowensville, S. C., in 1878, and was educated at Furman and Cornell Universities.

Professor Earle has been connected with Clemson College ever since he was graduated from Cornell in 1902. He was assistant professor of mechanical engineering for one year, associate professor from 1903 to 1910, director of the engineering department and professor of mechanical engineering from 1910 to date, and also director of the engineering experiment station since 1924. The college has its own light and power plant, two pumping stations, and independent sewage system, all of which come under Professor Earle's supervision. He designed and installed the ice and refrigerating plant, designed a central-heating plant for several college buildings and a large church in connection with the college, and had charge of the wiring and plumbing of all residences on the campus.

During Dr. Riggs' absence in France in 1919, Professor Earle was acting president and again filled that office from the death of Dr. Riggs in January, 1924, until July, 1925, when the present incumbent, Enoch Walter Sikes, took office. From 1918 to 1920, he was a member of the Public Service Commission of South Carolina and also was consulting engineer for the Apple Valley Orchard and Nursery Company.

In 1905, Professor Earle was elected a junior

S. B. EARLE

member of the Society, became an associate in 1908, and was transferred to Member grade in 1914. He was a member of the executive committee of the Greenville Section from 1923 to 1926, served as chairman of the Section in 1935 and 1936, and, at present, is again a member of the executive committee. In 1935 and 1936, he was a delegate from Group IV to the Local Sections Conference.

In addition to his many activities in the A.S.M.E., Professor Earle is a member of the Society for the Promotion of Engineering Education and served on the council from 1927 to 1930; a member of the South Carolina Society of Engineers, serving as a director in 1929 and 1930 and as president in 1933; and a member of the National Engineering Council Committee on Unemployment; from 1932 to 1935, he was chairman of the engineering section of the Association of Land Grant Colleges and Universities. He is a Fellow of the American Association for the Advancement of Science and the South Carolina Academy of Science and a member of Tau Beta Pi, the national scholastic honorary engineering fraternity. Furman University conferred the degrees of A.B., A.M., and LL.D. in 1898,

1899, and 1932, respectively, and Professor Earle received an M.E. from Cornell University in 1902.

Frank H. Prouty

FRANK H. PROUTY, one of the nominees for the office of Manager of The American Society of Mechanical Engineers, is a partner in the Prouty Brothers Engineering Company and the Industrial Appraisal Company, both

FRANK H. PROUTY

located at Denver, Colo. He was born in that city in 1891, and was graduated from the University of Colorado, Boulder, Colo., in 1915 with the degree of B.S. in civil engineering. The University also conferred the M.E. degree upon him in 1927.

For eight months after graduation, he was an assistant highway engineer in the U. S. Forest Service and surveyed and constructed roads through the forest reserve. From 1916 to 1918, he designed a boilerhouse, various buildings, and associated structural work for The Colorado Fuel & Iron Co. The next two years were spent at the Lorain, Ohio, plant of the National Tube Company, where he was a special designing engineer in the rolling-mills department and designed numerous mechanical improvements, such as mill housings and tables, manipulators, material-handling devices, engine parts, valves, piping systems, and buildings. From 1920 to 1924, he was assistant superintendent of the steam and combustion departments at the Cambria plant of the Bethlehem Steel Company, Johnstown, Pa. In this connection, he had charge of 20 boilerhouses and designed many mechanical improvements. He also had charge of tests affecting every department of the plant and distribution of service costs.

Since June, 1924, Mr. Prouty has been engaged in the practice of consulting engineering at Denver. He has appraised approximately one half of the beet-sugar factories in the United States, including those of the Great Western Sugar Company, the American Crystal Sugar Company, and the Great Lakes Sugar Company, Toledo, Ohio. He was consulting engineer in 1927 for the City of Denver in connection with the reappraisal for tax purposes of all mechanical equipment in that city, has served as consulting engineer for the Public Service Commission of Wyoming on rate cases, and has appeared before various courts and commissions in numerous rate cases involving the appraisal of gas, water, electric, and telephone properties.

Mr. Prouty is the originator of several boilerhouse specialties and the designer of a truck-mounted power shovel and numerous boilerhouses and power plants. He has contributed articles to technical periodicals and was a joint author of "Appraisers and Assessors Manual."

He became a member of the Society in 1925, was chairman of the Colorado Section in 1930 and 1931, served on the Nominating Committee in 1934, and is now a member of its executive committee. In addition, he has been president of the Colorado Society of Engineers and, this year holds that office in the Colorado Engineering Council.

1800 Potential A.S.M.E. Junior Members

COMMENCEMENT exercises in 114 engineering colleges throughout the United States will release this year more than 1800 student members of The American Society of Mechanical Engineers to the engineering profession. These men represent 1800 potential A.S.M.E. junior members and the obligation now rests upon the 73 Local Sections of the Society to assist in their assimilation.

Urged to Make Transfer Effective

President Herron has written to the honorary chairman of every student branch requesting that when the notices of transfer from Student Member to Junior are handed to the 1800 graduates so honored on commencement day the men be advised and encouraged immediately to take the necessary action to make that transfer effective by paying a quarter of the first year's dues. When this payment is made the men automatically become junior members of the Society and members of the Sections in Junior Groups formed in those localities where they will take up their engineering work.

All members of the Society and particularly the officers of local sections and the honorary chairmen of student branches are urged to cooperate in assimilating these new members of the mechanical-engineering profession. Every act of helpfulness rendered to the incoming juniors at this time will be greatly appreciated by them and create the feeling that the Society is really attempting to be helpful to them.

Each Section to Have List of Men

Each local section will be provided with a list of men coming into its area. It is hoped that in the 32 sections where junior groups are functioning these men will be recognized in some formal way at the first meeting of the group held after their arrival, and that in the other 41 sections the officers will utilize these young men in an effort to organize junior groups. The local sections' officers in localities where there is a student branch can cooperate with the honorary chairmen because obviously many graduates of that particular college will remain in the section's area. The sections' officers may be helpful also in influencing the student members who are going to other localities to realize the opportunities offered them if they will promptly get in touch with officers of the local section of that area.

Junior groups are functioning in the following sections: Akron-Canton, Baltimore, Bridgeport, Chicago, Cincinnati, Cleveland, Dayton, Detroit, Florida, Hartford, Central Indiana, Kansas City, Knoxville, Los Angeles, Metropolitan, Mid-Continent, Milwaukee, Nebraska, Ontario, Oregon, Philadelphia, Pittsburgh, Plainfield, Providence, St. Louis, Schenectady, South Texas, Syracuse, Tri-Cities, Washington, D. C., Western Washington, and Worcester.

A.S.M.E. Calendar

of Coming Meetings

August 18–21, 1937
Oil and Gas Power Meeting
Pennsylvania State College
State College, Pa.

October 4–6, 1937
Fall Meeting
Erie, Pa.

October, 1937
Wood Industries Meeting
Grand Rapids, Mich.

October 15, 1937
Textile Meeting
Boston, Mass.

October 27–28, 1937
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Pittsburgh, Pa.

December 6–10, 1937
Annual Meeting
New York, N. Y.

March, 1938
Spring Meeting
Los Angeles, Calif.

June 20–24, 1938
Semi-Annual Meeting
St. Louis, Mo.

Elmer H. Neff Honored

ON APRIL 17, 1937, Elmer H. Neff, life member, A.S.M.E., completed his fortieth year as New York representative of the Brown & Sharpe Manufacturing Company, and its later subsidiary, Brown & Sharpe of New York, Inc. On that anniversary he relinquished charge of the New York Office and retired from active service. An informal dinner was given by his former associates. Mr. Neff has attended practically every A.S.M.E. meeting since 1898 and has participated in its discussions on factory equipment, production, and education and training for the industries.

Attendance of Over a Hundred at National Rayon Textile Conference in Washington, D. C.

Discuss Progress Made and Future Improvements

THE FIRST National Rayon Textile Conference co-sponsored by the American Association of Textile Chemists and Colorists, Committee D-13, American Society for Testing Materials, U. S. Institute of Textile Research, Throwsters Research Institute, and the Textile Division of The American Society of Mechanical Engineers was held on May 14 and 15, 1937, in the East Building of the U. S. Bureau of Standards, Washington, D. C.

Progress made to date in the manufacture of rayon yarns and fabrics and the opportunities for further improvements in spinning, throwing, weaving, and finishing were topics of discussion.

The technical sessions, which were held were arranged by the co-sponsoring groups and in addition an informal dinner was held on Friday evening.

Friday's Sessions

Over one hundred engineers, chemists, and other technicians attended the meeting. At the session on Friday morning M. X. Wilberding, chairman of the Washington, D. C. Section of the A.S.M.E., welcomed the visitors to Washington and introduced Dr. Lyman J. Briggs, director of the U. S. Bureau of Standards.

Dr. Briggs explained the many functions of the Bureau and told of the various textile researches and studies being carried on there. He stated that technical men have direct responsibility not only to their employers but also to the whole industry as well if we are to progress, as new industries must be found and new jobs created to take up the slack and changes that occur in industry.

The chairman for the morning session, C. H. Ramsey, president, Morrison Machine Co., was next introduced and he in turn presented the first speaker, L. L. Lewis, vice-president and chief engineer, Carrier Corporation, who read a paper entitled "Air Conditioning for Textile Plants Making and Using Synthetic Yarns."

The second paper by Albert Palmer, Crompton & Knowles Loom Works, Worcester, Mass., on "The Mechanics of Synthetic Fiber Weaving" was followed by a film showing slow-motion studies carried on by this company in loom building and operation.

The Friday afternoon session with Dr. Louis A. Olney as chairman, had as its first speaker, W. F. Macia, research fellow, A.A.T.C.C., Throwsters Research Institute and Textile Foundation, whose paper was devoted to the "Cause of Rayon Crepe Variations With Special Reference to Throwing," discussed the researches conducted by the organizations which he represented. James McGibbon, of the North American Rayon Corporation, presented the second paper of the session, "Effect of Embossing and Boil Off on Finishing Crepe Fabrics."

At the Dinner

An informal dinner was held in the continental room of the Wardman Park Hotel at which Mr. Wilberding presided. Dr. H. E. Howe, editor of *Industrial & Engineering Chemistry*, was the toastmaster upon this occasion. After some witty remarks concerning the perfection of fibers and fabrics and the research work in dyes and finishes, Dr. Howe introduced Howard Ketcham, president of Howard Ketcham, Inc., New York City, whose topic "Color Comes of Age," was handled most skillfully and with great interest to his audience. It was followed by a showing of the film on "The Manufacture of Rayon Yarns" furnished by the Viscose Company.

Saturday's Sessions

The Saturday morning session held at the Bureau was presided over by Prof. H. J. Ball, of Lowell Textile Institute, who represented Committee D-13 of the A.S.T.M. He introduced Ephraim Freedman, director of Macy's Bureau of Standards, who spoke on "The History of Rayon in the Retail Trade." To illustrate the trend in rayon fabrics Mr. Freedman displayed both materials and dresses.

Another interesting address was that presented by Dr. F. Bonnet of the Viscose Company, Marcus Hook, Pa., on the "Manufacture and Uses of Cut Rayon Staple." The last paper of the session presented was by G. W. Hinkle, metallurgist, Republic Steel Company, Massillon, Ohio.

The Conference was a most successful one and considered a decidedly worth-while undertaking and the A.S.M.E. Textile Division is hopeful of holding another such conference in 1938.

A limited number of copies of the papers presented have been mimeographed and are available upon request.

A.S.M.E. Management Division Announces Appointments

ITEMS of interest to members from the meeting on May 24 of the executive committee of the Management Division concern appointments of the Division's representatives.

There were present at the meeting L. C. Morrow, chairman; H. W. Kushnick, vice-chairman; Chapin Hoskins, functional advisor on economics; M. F. Skinker, functional advisor on quality control; and L. N. Rowley, Jr., secretary.

It was announced that acceptances had been received from the following representatives of the division in the local sections named: John T. Croghan, Boston, Mass., Frederick G. Hughes, New Britain, Conn., and William K. Simpson, Waterbury, Conn.

The resignation as representative of the A.S.M.E. on the National Management Council of Joseph W. Roe, because of his retirement from active teaching at New York University, was regretfully accepted, and the naming of his successor was left to the chairman of the committee.

It was also announced that W. L. Batt, past-president of the A.S.M.E., had accepted appointment as the Division's representative on the A.S.M.E. Council.

A.S.M.E. and A.I.M.E. to Hold Joint Coal Meeting

Fuels and Coal Divisions to Meet in Pittsburgh in October

THE FUELS Division of the Society will hold a meeting jointly with the Coal Division of the American Society of Mining and Metallurgical Engineers, in Pittsburgh, Pa., October 27–29, 1937, with headquarters at the William Penn Hotel.

The program as developed by the A.I.M.E. Coal Division will treat the subject of fuel from the viewpoint of the preparation and treatment of coal whereas the A.S.M.E. part of the program will be devoted to the use of coal as a fuel and the various types of apparatus adapted to the several forms in which coal may be prepared.

It is expected that these papers will come within the following categories:

(1) Selection of coal for pulverizers
(2) Underfeed stokers from the standpoint of coal selection
(3) Chain-grate stokers
(4) Small underfeed stokers.

As it is the hope of the committees of both organizations in charge of this meeting to develop an annual or biennial meeting of this character all members of the A.S.M.E. are invited to cooperate by sending to A. R. Mumford, secretary, Fuels Division, A.S.M.E., 29 West 39th Street, New York City, the names and addresses of nonmembers who may be interested in receiving an invitation to attend the meeting. All members of the A.S.M.E. who are not enrolled in the Fuels and Steam Power Divisions of the Society and who are interested in receiving complete information about this meeting are urged to so advise the Secretary.

The local Pittsburgh Committee is developing arrangements for visits to several plants where apparatus may be seen illustrative of the type which will be described in the papers. Detailed information regarding these plant visits will be given in a later issue of MECHANICAL ENGINEERING.

Other Engineering Activities

The Annual Langley Field Conference

New and Valuable Data the Result of Year's Research

THE N.A.C.A. received so many requests this year for attendance at the Langley Field Conference on May 20, that the visitors were divided into two groups, and two demonstrations were given, with a day intervening.

While the day of startling aerodynamic innovations has perhaps gone, the Committee presented much new and valuable information as the result of the year's research, and is making steady and consistent progress. The outstanding developments were the introduction of a "free-flight tunnel" and the final calibration and "putting to work" of the high-speed, 500-mph, 8-ft wind tunnel.

Free-Flight Tunnel

Experience with the vertical free-spin tunnel has been most satisfactory and designers have been able to secure rapid and reliable qualitative answers to their problems having reference to the airplane spin. Encouraged by this experience, the Committee has constructed the "free-flight tunnel" for similar qualitative investigations in more normal attitudes of the airplane. A short, rather crude wind channel (with the air stream created by a propeller of conventional design) is so constructed that it is hinged above, and can be tilted by a vertical, worm gear and electric-motor-operated strut placed below. With the tunnel tilted a light model operates in an upwardly directed current of air, and as the air speed is increased and the model rises from the channel floor, it glides, while remaining stationary in space, just as a glider can soar indefinitely in the upward currents near the side of a cliff. Electromagnets placed within the model, controllable by the research worker, operate rudder, ailerons, and elevator. Hence it is possible to study visually the effects of the controls, the carrying out of various maneuvers, and to simulate gusts by tilting the tunnel rapidly up or down. An interesting and novel piece of research equipment has been added to aeronautical science.

Gust Tunnel

Another interesting piece of research equipment appeared in the form of a new "gust tunnel." A model is catapulted down an inclined cable and passes over a vertical tunnel in which gusts of varying intensity and distribution can be simulated. Together with the acceleration and velocity recorders located on some 160 air liners, over land and water, the Committee is accumulating information which will be a sound basis for stress analysis.

Studies in the high-speed tunnel at 325 mph indicate that the compressibility burble encountered in the airfoil, will also be encountered in the engine cowl, and if our airplanes are ever to exceed such speeds, engine cowls will have to be specially rounded to avoid shock waves and enormous increase in drag. Other studies in the high-speed tunnel indicate the extreme importance of absolutely smooth wing surfaces, with all rivet heads absolutely flush. It may be necessary in air-transport operation, to dust off accumulations of dirt between trips if maximum performance is to be maintained. Other ideas propounded were the mounting of the engine inside the wing (to avoid nacelle drag) with pusher propellers mounted in back of the trailing edge of the wing and the improvement of seaplane take-off by maintaining the best trim at all times by the use of an optical trim indicator.

The Committee stepped out of the strict field of aerodynamics by suggesting the use of catapults for heavily loaded transports. Wing loadings of 35 lb per sq ft may be confidently expected in the near future and then the take-off run would be 1800 ft which is excessive. With an acceleration of only $\frac{1}{2}$ g, this would be cut to 1150 ft. For a Douglas DC-4 weighing 60,000 lb the catapult thrust would be 15,000 lb and would entail 3200 hp. Therefore the following scheme is propounded:

"The catapult apparatus would be located in the center of the airport in a pit below the surface of the airport. The catapult would be on the turntable so as to permit operation in any direction to take advantage of the wind in taking off. A power unit of 3250 hp under such conditions would be difficult and expensive to operate. However, if energy is stored in a flywheel and about five minutes is allowed to bring the flywheel up to speed, it is possible to use an electric motor of relatively low horsepower and cost."

Altogether a most stimulating and successful conference.

[The foregoing report was prepared by Prof. Alexander Klemin, professor of aeronautical engineering at the Daniel Guggenheim School of Aeronautics, New York University, and official representative of the A.S.M.E. at the Langley Field Conference.—EDITOR.]

Detroit Engineering Society Has Another $500,000

THE Engineering Society of Detroit has just received a second gift of $500,000 from The Horace H. and Mary A. Rackham Fund which brings the total endowment for The Engineering Society of Detroit to $1,000,000. The purpose of the second gift is to provide a suitable building to be used as a permanent home. The income from the first half million is to be used for operating expenses.

Do You Have Historical Drawings for Display?

F. W. MING, assistant professor of mechanical engineering at the Polytechnic Institute of Brooklyn, has sent us the following note:

Here at the Institute we have two illuminated display glass-enclosed wallboards about 7 ft long by 3 ft wide and we wish to secure material of an historical nature for display within them. Do you happen to know where I might get old drawings or paintings or similar material of interest to engineering students? The boards are about 3 in. deep and suitable for framed pictures.

If you are able either with suggestion or drawings to help Professor Ming, will you communicate with him at the Institute?

Engineering Societies Library Saves Money

AT A meeting on May 13, 1937, of the Library Board of the United Engineering Trustees, Inc., Harrison W. Craver, director, explained how the Engineering Societies Library is saving money on its catalog insurance and showed why increased appropriations are needed for enlarging library service.

By means of the microfilm method the library's catalog cards of 151,512 volumes, maps, and searches are being copied at a cost of less than $400. Should this valuable collection of cards be destroyed, it is estimated that new cards can be prepared photographically within a very short time from the microfilm copies at a cost of about $2000. Thus the Board has voted to reduce the amount of insurance on the catalog to a figure sufficient to cover the cost of the microfilm and the preparation of the new cards. This substantial saving in insurance is a practical economy that demonstrates the alertness and sound business sense of the library administration.

The Board also voted to reduce insurance carried on its rare-book collection on the principle that the library is not a museum but a collection of working material. As the library owns no unique volumes, destruction of any valuable rare books, while representing a definite loss, would not be irreparable injury to library service. By means of the microfilm service, any rare book could be copied from other collections at a relatively small cost, should its use be required by the library. The Board expressed the opinion that operating funds were of greater value to it and to the members of the Founder Societies than insurance premiums paid out on rare books.

A report by the Committee on Library Development was received by the Board, and recommendations contained in it looking toward an increase in funds to be used for enlarging the usefulness of the Library's services were approved. The report pointed out the need that the Library feels of adding competent trained persons to its staff, and the difficulty of holding together the present staff in the face of higher salaries offered to its

skilled workers by other libraries. It recommended that, until adequate staff is available, service to other libraries be limited to an expression of willingness to advise as may be possible in answer to specific inquiry, and that consideration be given to increasing the Library's capacity for efficient handling of searches.

Representatives of The American Society of Mechanical Engineers on the Library Board are L. K. Sillcox, J. S. Kerrins, and A. R. Mumford.

Office Machines Research Offers Service of Information

ANNOUNCEMENT has been made of the inauguration in July, 1937, of a service of information by a corporation known as Office Machines Research, Inc., to conduct an independent and scientific investigation and analysis of office machines and to report monthly on the technical construction, the operative capabilities, and the specific applications of machines now on the market and of all new developments as they occur. Ownership in the company is closely held and no stock is available for purchase by any manufacturer of office equipment. The service will be entirely impartial and scientifically as accurate as research and experience can make it.

The service is to be issued under two classifications: (1) The American edition which will include reports upon American machines and those foreign machines which are obtainable on the American market; (2) a foreign supplement which will contain reports upon foreign machines not at present upon the American market but of general interest in a consideration of the subject.

Headquarters of the new organization is at 630 Fifth Avenue, New York, N. Y.

New Plant Equipment and Machinery at Chicago Power Show

NEW types of power-plant equipment and the latest machinery for the numerous industries which utilize mechanical engineering will be featured at the Chicago Exposition of Power and Mechanical Engineering, October 4 to 9, 1937.

In the selection of the Mid-West industrial center as a power show location, Chicago's prominence as host to famous expositions is recalled. The new International Amphitheatre, one of the largest exposition halls in the world, will provide an adequate setting for the event.

Equipment on display will include the following classifications: fuels; combustion equipment; refractories; steam-generating equipment; steam distribution; accessories; piping and fittings; prime movers; pumps and hydraulic equipment; electric generators and motors; electrical transmission, distribution, and control devices; power-transmission accessories; instruments of precision; tools and machine tools; power-driven units; materials-handling systems; factory air-conditioning equipment; lubricants; refrigerating machinery; operation and maintenance materials.

Engineers' Congress, Sept. 26–29, at Paris Exposition

IN connection with the International Exposition this year in Paris, a Congress of Engineers is being called to meet on September 26–29. The subjects to be considered in the program have to do with the economic and social relations of the engineer, his education, and his relationship to engineering legislation.

Members of the A.S.M.E. who are planning to be in Paris at that time are asked to inform the Secretary so that further information about the Congress may be provided.

C. E. Kenneth Mees Is Awarded Henry Draper Medal

AT A dinner meeting of the National Academy of Sciences in Washington, D. C., on April 27, 1937, the Henry Draper Medal was awarded to Dr. C. E. Kenneth Mees, mem. A.S.M.E., director of the Research Laboratory of the Eastman Kodak Company, Rochester, N. Y., as recognizing and encouraging the development of photography as applied to astronomy.

Dr. Mees was presented for the award by Dr. Frank Schlesinger of the Yale Observatory, who said in part:

Dr. Mees has devoted his life to the development of the theory and the perfection of photographic processes and materials. His early prominent piece of work "Investigations on the Theory of the Photographic Processes" published in 1907 in collaboration with Sheppard has since been a classic on the subject. This gave him wide distinction and he was called to America in 1912 where since he has been continuously occupied in this field of endeavor at the Eastman Kodak Research Laboratory.

At the beginning of the present century it was hardly possible in astronomy to photograph a spectrum of more than about 2700 Angstrom units, but today fully twice that length of spectrum has been added. Much of this great gain has resulted from the development of emulsions and sensitizers at the hands of Dr. Mees. His wide extension of the photographable spectrum into the longer wave lengths carries ever greater scientific importance than might at once be evident for it brings us knowledge of a vast new portion of the energy of the stars. And this means our knowledge of the heavenly bodies may not be builded upon this broader foundation.

In accomplishing these and other advances for photography Dr. Mees has contributed to the general progress of science as well as to astronomy in particular.

Thus for 30 years he has carried on with marked ability and skillful technique fundamental researches.

George Montefiore Foundation Prize Awarded Triennially

APRIL 30, 1938, has been set as the latest date upon which papers may be submitted to the jury of award for the George Montefiore Foundation Prize. This prize is awarded every three years on the basis of international competition for the best original work in scientific progress and progress in technical application of electricity in any of its branches. Popular works and simple compilations are excluded. Papers submitted are subject to the following general stipulations:

Only such papers as have been prepared during the three years preceding the meeting of the acting jury will be accepted. Papers must be either printed or typewritten in both French and English and twelve copies sent postpaid to M. le secrétaire-archiviste de la Foundation George Montefiore, rue Saint-Gilles 31, Liege, Belgium, by whom they will be acknowledged to the author. A majority vote of four-fifths by the Board of Award allows of one third of the amount available to be bestowed for the presentation of a valuable discovery in the scientific field or the statement of a new idea which may lead to an important electrical development.

Should the prize for any year not be awarded or any portion of it remain undistributed, this amount will be added to the award for the next triennial period. Any paper upon which the jury decides will be published in the Bulletin de l'Association des Ingenieurs électriciens sortis de l'Institut électro-technique Montefiore, 25 reprints to be sent to the author free of charge but no further profit to be derived by him from its reprinting. The award carries with it a gratuity of 18,000 francs.

It will be distributed at the discrimination of the jury of award which is composed of ten electrical engineers, all holding diplomas of the Institut Electro-technique Montefiore, five Belgians and five others presided over by the director of the Institut. who automatically becomes one of the Belgian delegates.

At the head of all papers submitted, or in some other conspicuous place should be plainly written: "Travail soumis au concours de la Foundation George Montefiore, Session de 1938" (Papers submitted for the competition of the George Montefiore Foundation).

New Officers of the Gear Manufacturers Association

NEW officers of the American Gear Manufacturers Association were elected at its annual meeting in Wernersville, Pa., in May, as follows: President, H. H. Kerr, of North Quincy, Mass.; vice-president, Howard Dingle, of Cleveland, Ohio; treasurer, J. Harper Jackson, of Pittsburgh, Pa. Members elected to the executive committee included H. Dingle, R. C. Ball of Philadelphia, Frank B. Drake of Berkeley, Cal., and U. Seth Eberhardt (Mem. A.S.M.E.) of Newark, N. J.

(*More* A.S.M.E. NEWS *on page 564*)

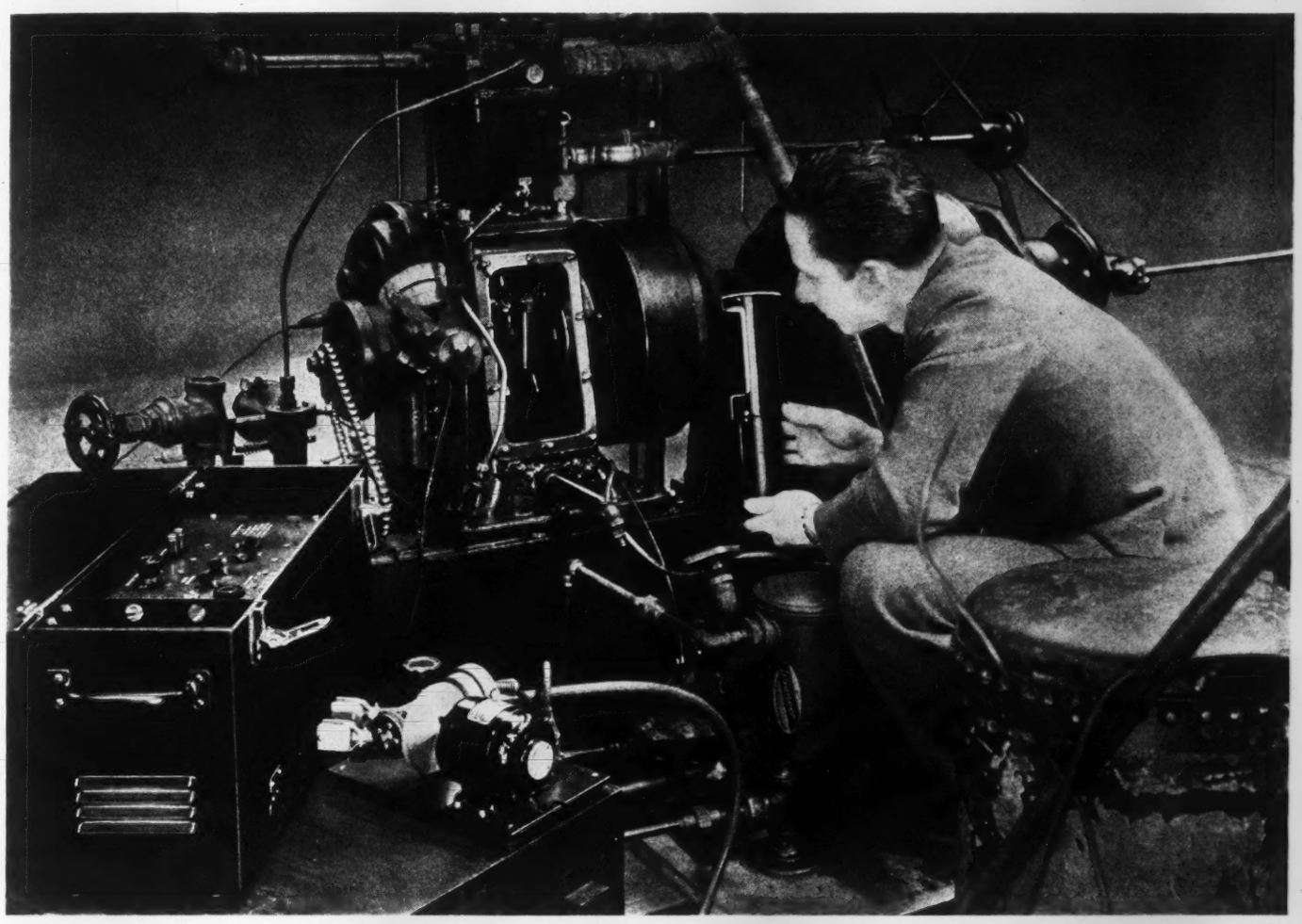


Photo Courtesy Massachusetts Institute of Technology

Studying Diesel Action

OBSERVING the *exact* operation of this CFR Fuel Research Engine with Comet head at Massachusetts Institute of Technology is exceedingly simple with the General Radio Type 548-B Edgerton Stroboscope. The Stroboscope is the enlarged model of the STROBOTAC hundreds of which are being put to thousands of different motional study uses daily. The Type 548-B Stroboscope supplies *ten times* as much light as the STROBOTAC. It is used where large machines or parts are to be examined in very bright light.

Studying the operation of crankshafts, connecting rods, counter weights, valves and valve springs, crankpin bearing clearances, side shifting of crank boxes and many misadjustments in the operation of any Diesel can be performed as routine maintenance with a General Radio Stroboscope.

Profit by the experience of hundreds of other engineers, research men, production managers and maintenance superintendents . . . . . investigate the possibilities of a Stroboscope in *your* plant.

Write for Bulletin 147-W for complete data on all General Radio Stroboscopic devices.

The Type 548-B Edgerton Stroboscope with synchronous motor contactor and mercury-vapor lamp is priced at $360.00. The smaller Type 631-A Strobotac complete with built-in contactor is priced at $95.00. Bulletin 147-W completely describes both instruments. Write for a copy!

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The News From Washington

By American Engineering Council

Fees for Engineers' Services Studied by A.E.C.

THE American Engineering Council's staff has completed a report for the American Society of Civil Engineers which includes a comprehensive survey of government agencies employing engineers on a contract, per diem, or percentage fee basis. Each agency was interviewed regarding its practice and an examination was made of laws, regulations, and procedures affecting the engagement of technical talent and especially engineering services, by the federal government, not in conflict with the civil service. As a result more than thirty important agencies are listed in the report with references to the laws or rulings governing procedure in each bureau and the fees paid or the method for determining fees. The extent of the use of consulting-engineering services was difficult to determine, but it is also indicated in many instances.

On first consideration, the student of this complex situation is impressed with the lack of uniformity and the need for standardization of employment procedure. No one seems to be perfectly satisfied with present practice, and most officials desire simplification and clarification of their rights to engage necessary full-time employees of proper qualifications and to call upon consultants from time to time for expert advice and assistance. As the study progresses, however, it becomes evident that even an all-inclusive career service with adequate provision for the use of private consulting advice and assistance would be difficult to standardize impartially.

Trends in Public Employment for Engineers

ENGINEERING employment by government agencies in Washington is somewhat disturbed by the threats of both Congress and the Administration actually to apply economy measures. The President has ordered all departments, administrations, and commissions including the Bureau of the Budget materially to reduce current expenditures and to limit future operations to be budgeted within the national income. Congress seems to have accepted the President's advice, and to have set itself to the task of reducing federal expenditures.

In recognition of operating difficulties likely to develop as more of the better engineers return to private employment and practice, the Civil Service Commission is planning to conduct an unassembled examination for engineers of the several grades of a dozen branches of engineering at an early date. Although civil service cannot be made more attractive in either classification or compensation until there is new legislation in that direction, an effort is being made to raise educational and experience standards for each grade, with the hope that engineers better fitted for public service may be induced to qualify for the design, construction, operation, and maintenance of public property, and for research, educational or advisory, and supervisory or inspection duty in the several lines of accepted public service.

Without becoming involved in anything leading toward the socialization of engineering or the standardization of either duties or salaries which might limit engineering initiative, the Council, through its staff and committees, is aiding the Commission and its "engineer examiners" in their efforts to improve the engineer personnel under civil service. This opportunity to forward engineering recognition and to act indirectly for the improvement of the economic status of the engineer in public service, comes to the American Engineering Council as an invitation from the Civil Service Commission. Council is thus accepted as an instrumentality of organized engineering in position to express the united opinion of engineers regarding the qualifications for and conditions of the employment of engineers by those arms of the federal government of the United States whose employees are under civil service. In that position, the Council may well be a stabilizing influence against unionization.

R.E.C. to Use Consulting Engineers

RURAL electrification administration had its second birthday on May 11, 1937. As of that date R.E.A. had approved 310 projects involving $58,952,958. Of that amount, about $56,862,958 will be used for line construction; $1,980,000 for building generating plants; and $110,000 for financing wiring and plumbing installation. Loan contracts have been executed for more than $45,500,000 of the allotted funds. Projects totaling about $32,000,000 have reached some one of the several stages of construction and according to R.E.A. enough wire has been strung on projects which it has financed to reach twice around the earth at the equator.

Rural Electric Cooperatives are now required to use consulting-engineering services. The cooperatives may also employ skilled management even before the lines are built and charge such salaries against R.E.A. loans until the project is completed and in operation. Help in building "load" is being supplied by R.E.A. experts working in the field under the direction of a small headquarters staff in Washington.

Positions Available

Engineering Societies Employment Service

GENERAL MANAGER for factory employing about 80 men, manufacturing ground and lapped parts of highest grade and precision on modern quantity-production basis. To take full charge of factory, including purchasing, and to organize various departments to increase production. Only engineer thoroughly familiar with modern quantity-production methods and all phases of grinding, lapping, and screw-machine work will be considered. Must have held executive positions with reputable concerns. Apply by letter giving full particulars of training, experience, references, including photograph. Location, Middle West. Y-1507-C.

PROFESSOR, 35–40, to act as head of mechanical-engineering department. Engineer with both teaching and practical experience preferred. Apply by letter. Location, New England. Y-1508.

WORKS MANAGER, mechanical engineer, 35–45, with experience in machine-tool operation, particularly in jobbing type of shop. Knowledge of foundry practice desirable. Should have held position as superintendent or works manager, and be able to handle labor as plant employs approximately 600. Salary, $6000–$7000 a year. Apply by letter. Location, Middle West. Y-1512-C.

GRADUATE MECHANICAL OR ELECTRICAL ENGINEERS, 2, ages about 25, single, out of college for a year or two with experience in the sale of lubricating oils. Salary, $200 a month. Apply by letter. Location, Orient. Y-1516.

EXECUTIVE AND DEVELOPMENT ENGINEER, mechanical, 35–40, to take charge of engineering department, exclusive of design work, of manufacturing company. Must be able to cooperate with and direct work of factory, and able to handle men. Experience in electrical or gas appliances desirable. Apply by letter. Location, East. Y-1593.

DESIGNER, technical graduate, about 30, for general design on trucks, busses, and parts. Experienced mainly in drafting and designing departments of automotive companies or machine-tool plants. Engineer in East preferred. Apply by letter. Y-1605.

ASSISTANT WORKS MANAGER, 35–45, to take charge of brass division. Must have experience in extrusion of brass tubes and brass rods. Apply by letter. Headquarters, East. Y-1621.

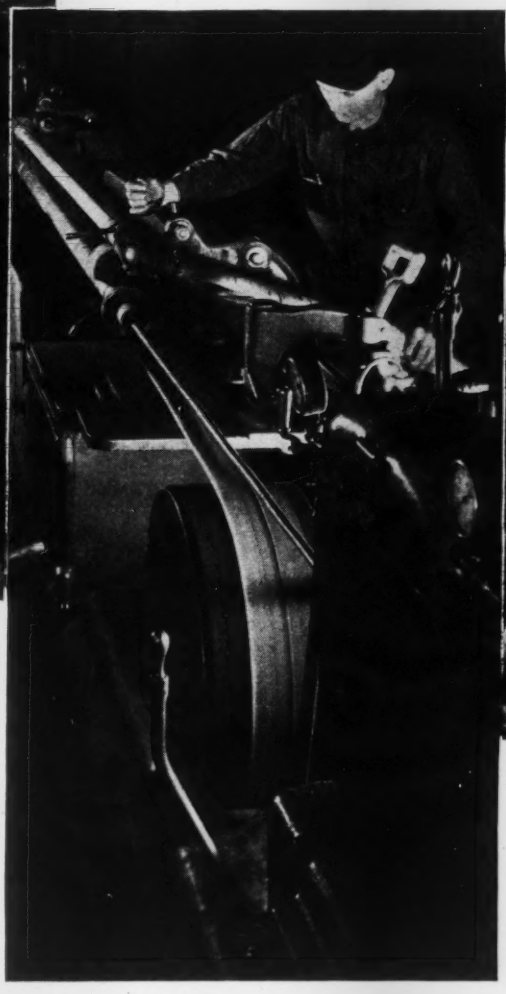
ENGINEER to work out efficient layout of factory for manufacture of ball bearings. Will help select and supervise installation of necessary machinery. May eventually become fac-

(Continued on page 566)

Whenever You Buy Stainless Equipment

THERE ARE THREE ADVANTAGES IN SPECIFYING "U·S·S"

. . . metal of the finest quality . . . made only in clean electric furnaces . . . exclusively devoted to the production of high-grade alloys . . . by men who make nothing else. (Above)



. . . cooperation, in the design of new equipment, of stainless steel specialists who can often suggest new wrinkles for saving on first cost, saving on operating cost, or both. (Above)

• • •

. . . availability in the widest variety of shapes and forms and modifications . . . including tubes inside-polished to make them as clean inside as they are outside. Here you see the inside-polishing operation. (Left)

THOSE well-known initials — "USS" — identify stainless steel of the finest quality made by the world's largest, most completely equipped producer of high-grade steels.

There are three important advantages to you in specifying that the equipment you order shall be built of stainless that is "USS".

Of first importance is the *metal itself*. The remarkable properties of stainless steel depend upon accurate composition, skillful heat treatment, precision control. When you specify "USS" for your equipment you get stainless steel of the finest quality it is now possible to make.

Also important is *availability*. USS Stainless Steel is available in every needed analysis; in the widest variety of shapes and forms and dimensions and modifications; for immediate delivery from warehouse stocks.

And our *metallurgical service* can be valuable to you also. You are cordially invited to call on our stainless steel specialists for recommendations, suggestions and new ideas. From their wide experience on many problems in many fields, these men can often suggest new wrinkles for saving on first cost, saving on operating cost, or saving on both.

Our aim is to serve you well — so well that you will always specify . . . "USS".

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AMERICAN STEEL & WIRE COMPANY, *Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
NATIONAL TUBE COMPANY, *Pittsburgh*

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

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